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NATIONAL DAM SAFETY PROGRAM: BLACK TAILINGS DAM (MO 31154), MIS--ETC(U)
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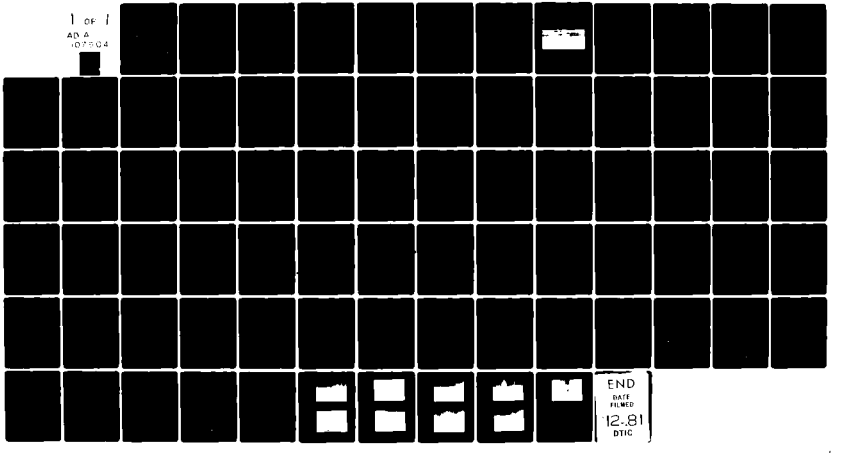

# MISSISSIPPI-KASKASKIA-ST. LOUIS BASIN

BLACK TAILINGS DAM
WASHINGTON COUNTY, MISSOURI
MO 31154

# PHASE 1 INSPECTION REPORT. NATIONAL DAM SAFETY PROGRAM.

United States Army
Corps of Engineers
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St. Louis District





PREPARED BY: U. S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI





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## REPORT DOCUMENTATION PAGE

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Approved for release; distribution unlimited.

Kenneth B. King James H. Gray
Donald E. Westcott

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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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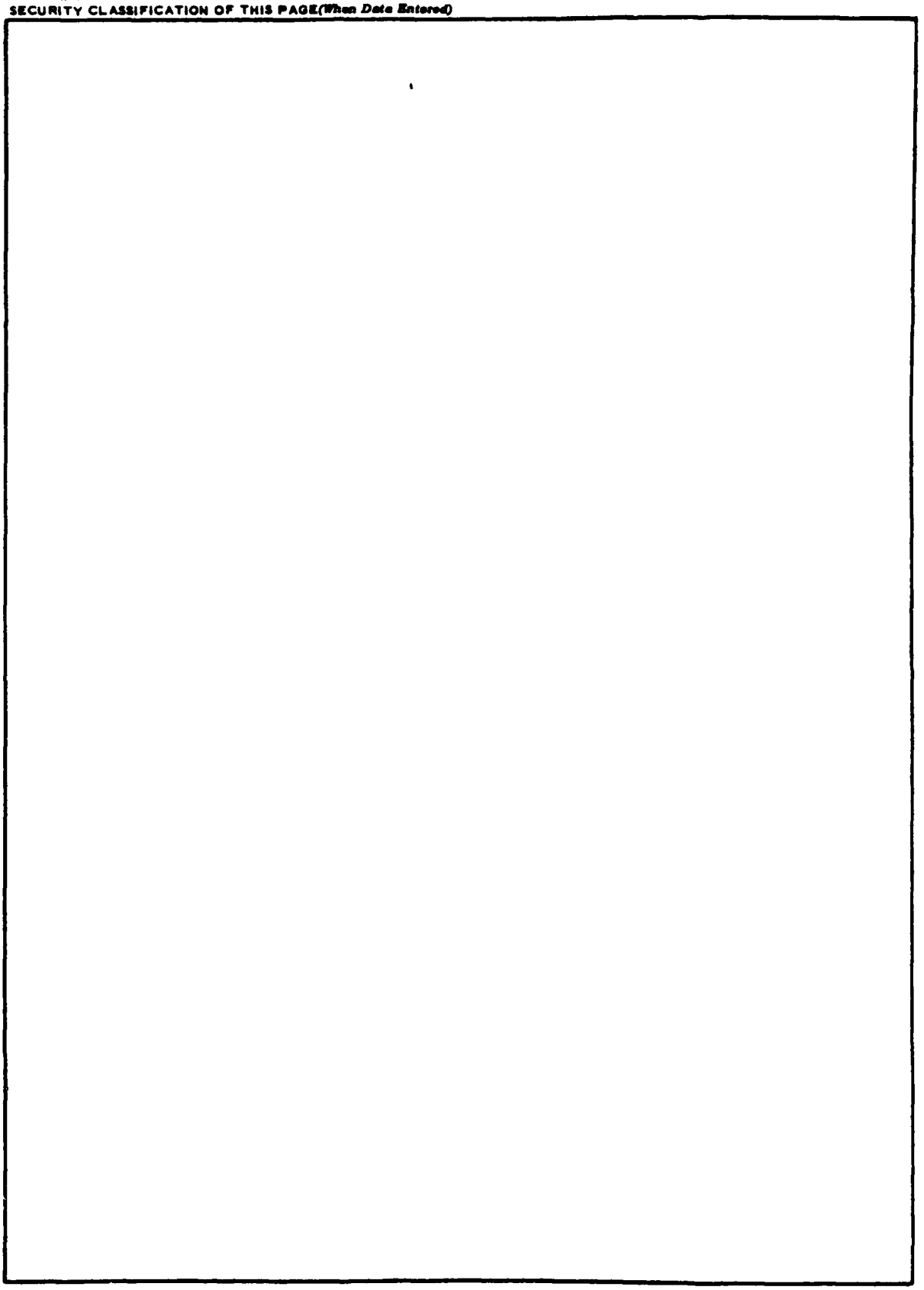

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ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO ATTENTION OF

LMSED-P

SUBJECT: Black Tailings Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Black Tailings Dam (MO 31154).

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, emergency by the St. Louis District as a result of the application of the following criteria:

1) This dam which has no spillway will not contain a 10-year frequency flood without overtopping occurring. The storage capacity of this dam is, therefore, considered to be unusually small and seriously inadequate.

2) Overtopping could result in dam failure.

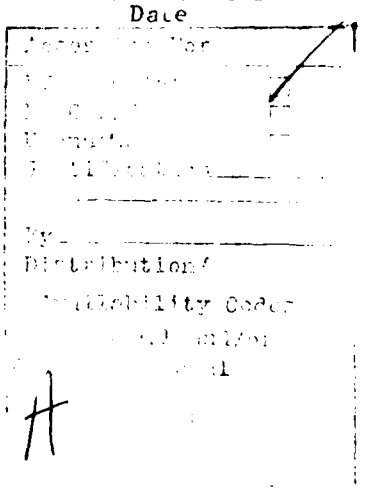
3) Dam failure significantly increases the hazard to life and property downstream.

SIGNED

SUBMITTED BY: _____ 22 APR 1980
Chief, Engineering Division — Date

SIGNED

APPROVED BY: _____ 22 APR 1980
Colonel, CE, District Engineer — Date



# BLACK TAILINGS DAM
# WASHINGTON COUNTY, MISSOURI

MISSOURI INVENTORY NO. 31154

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY
INTERNATIONAL ENGINEERING COMPANY, INC.
CONSULTING ENGINEERS
SAN FRANCISCO, CALIFORNIA

UNDER DIRECTION OF
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
FOR
GOVERNOR OF MISSOURI

AUGUST 1979

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

| | |
|---|---|
| Name of Dam | Black Tailings Dam |
| State | Missouri |
| County | Washington |
| Stream | Offstream from East Fork of Mill Creek |
| Date of Inspection | 8-9 April 1979 |

Black Tailings Dam, I.D. No. 31154, owned by Mr. and Mrs. Ray Black of St. Louis, Mo., was inspected by a civil engineer and an engineering geologist from International Engineering Company, Inc., of San Francisco, California. The purpose of the inspection was to assess the general condition of the dam with respect to safety. The assessment is based upon an evaluation of the available data, a visual inspection, and an evaluation of the hydrology and hydraulics of the site in order to determine if the dam poses hazards to human life or property. The purpose of the dam is to provide impoundment for barite ore tailings. The impoundment is inactive.

Black Tailings Dam was inspected using the "Recommended Guidelines for Safety Inspection of Dams" furnished by the Department of the Army, Office of the Chief of Engineers. Based on these guidelines, this dam is classified as being of intermediate size. The St. Louis District Corps of Engineers has classified this dam as having high downstream hazard potential. Failure of this dam could threaten life and property. The estimated damage zone provided by the St. Louis District Corps of Engineers extends approximately ten miles downstream of the dam. There are 21 dwellings, a railroad bridge, and the Town of Mineral Point within the first four miles of this damage zone.

The results of the inspection indicate an absence of facilities for discharging flood water, inadequate freeboard, and failure of the dam to meet the criteria given in the guidelines for a structure with the size and hazard potential of Black Tailings Dam. As an intermediate size dam with a high hazard potential, the guidelines specify that the discharge capacity and/or storage capacity should be capable of safely handling the Probable Maximum Flood (PMF) without overtopping the crest. The PMF is the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. It was calculated that the impoundment cannot retain the 100-year flood (a flood having a 1 percent chance of being equalled or exceeded in any 1 year) or the 10 year flood (a flood having a 10 percent chance of being equalled or exceeded in any 1 year) without overtopping the dam. The impoundment cannot retain 50 percent of the PMF without overtopping the embankment. It was estimated that the impoundment can retain 2 percent of the PMF without overtopping the crest.

Seepage, interrupted drainage, and soft marshy ground was observed at the dam toe. Action should be taken to drain this water away from the base of the dam.

Adequate overflow facilities and freeboard should be provided so that the impoundment can handle the PMF without overtopping the crest and without significant erosion of the embankment.

Seepage and stability analyses of this dam are not available. These studies should be performed by a professional engineer experienced in the design and construction of tailings dams and should be made a matter of record. Based on the results of these analyses, remedial measures may become necessary. Remedial work should be done under the direction of an engineer experienced in tailings dam design and construction.

A plan to permanently drain the impoundment and watershed and safely reclaim the site could be developed and implemented under the direction of qualified personnel as an alternative to the above measures recommended for the dam.

An inspection and maintenance program should be initiated. Periodic inspections should be made and documented by qualified personnel to observe the performance of the dam.

It is recommended that the owner take action to correct the deficiencies described.

Kenneth B. King, P.E.

James H. Gray, P.E.

Donald E. Westcott

Overview of Black Tailings Dam (31154) from Mineral Point

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
BLACK TAILINGS DAM
ID. NO. 31154

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# APPENDIX A

## HYDROLOGIC AND HYDRAULIC ANALYSES

## LIST OF PLATES



## PHOTOGRAPHS

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
BLACK TAILINGS DAM - ID NO. 31154

## SECTION 1 - PROJECT INFORMATION

### 1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspections of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of the Black Tailings Dam be made.

b. Purpose of the Inspection. The purpose of the inspection was to assess the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams." These Guidelines were developed with the help of several Federal agencies and many state agencies, professional engineering organizations, and private engineers.

### 1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) Black Tailings Dam is an earthfill dam that was used to impound barite ore tailings. The impoundment is formed by a curved dam blocking a small drainage basin offstream from Mill Creek.

(2) There is no active spillway at the dam.

b. Location. The dam is located in Washington County, Missouri, as shown in Plate 1. The dam is shown in Plate 2 and is located in Survey 3172, Township 37 North, Range 3 East (Latitude 37 degrees 56.8, Longitude 90 degrees 43.1).

c. Size Classification. Black Tailings Dam is greater than 40 feet but less than 100 feet high and is therefore classified as an intermediate size dam in accordance with "Recommended Guidelines for Safety Inspection of Dams".

d. Hazard Classification. This dam is classified as having a high hazard potential by the St. Louis District, Corps of Engineers. The estimated damage zone, as provided by the St. Louis District Corps of Engineers, extends approximately ten miles downstream of the dam. There are 21 dwellings, a railroad bridge, and the Town of Mineral Point within the first four miles of this damage zone.

e. Ownership. This dam is owned by:

Mr. and Mrs. Ray Black
8410 Pennsylvania
St. Louis, Missouri

f. Purpose of Dam. The dam impounds tailings that resulted from a barite separation and beneficiation operation. Tailings are no longer conveyed to the impoundment.

g. Design and Construction History. There is no written design or construction data available for this dam. Information obtained from Mr. Sy Williams, caretaker of the property, indicates that the Cadet Mining Company built the dam in 1942 and 1943; the impoundment was operated until 1953 by the J. E. Carter Company.

h. Normal Operating Procedures. No operating records are known to exist. Runoff into the pond is removed by seepage into the tailings evaporation and possibly overflow from the low spot at the left abutment. The facility is inactive in that tailings are no longer conveyed to the impoundment.

## 1.3 PERTINENT DATA

a. General. Field surveys were made by Booker Associates, Inc. of St. Louis, MO. on 16 April 1979. Field measurements are valid as of the dates of inspection and survey.

b. Drainage Area. 260 acres (USGS 7.5 minute quadrangle, Mineral Point, Mo., 1958).

c. Discharge at Damsite.

(1) Outlet Pipe - Nonfunctional.

(2) Total Spillway Discharge at Maximum Pool Elevation - No spillway for this dam exists.

d. Elevation (Feet above M.S.L.)[1/]

(1) Top of Dam - El. 897.7 feet to El. 903.2 feet.

(2) Crest at Maximum Section - El. 901.6 feet.

(3) Maximum Pool - El. 897.7 feet.

(4) Impoundment Levels on April 16, 1979 -

(a) near Station 12+00 - El. 895.6 feet.
(b) near intermediate spillway - El. 896.9 feet.

(5) Overflow Pipe (Invert) - 6-inch pipe - Sta. 4+30 - El. 902.0

e. Reservoir. (Tailings Pond)

(1) Length of Maximum Pool - 1200 feet ± (from ASCS airphoto BMH-3MM-231, 8-26-71).

(2) Length of Impoundment Pool - 800 feet ± (from ASCS airphoto 231).

f. Storage Capacity above Tailings Surface (Tailings Pond) - 22 acre-feet.

g. Reservoir Surface Area.

(1) Top of Dam (Maximum Pool) - 13 acres at El. 897.7 feet.

(2) Impoundment Level - 9 acres at El. 896.9 feet.

h. Dam.

(1) Type - earthfill.

(2) Length of Crest - 1430 feet ±.

(3) Maximum Height of Dam - 65 feet ±.

(4) Width of Crest - varies from approximately 25 feet to about 45 feet.

(5) Side Slopes -

(a) Downstream slope - approximately 1 V or 1.5 H.

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1/ Elevations are based on a reference elevation of 900.00 feet M.S.L. at the temporary bench mark. This datum was estimated from topographic data presented on the Mineral Point 7.5-minute Quadrangle Sheet.

(b) Upstream slope - unknown.

(6) Zoning - The dam appears to be constructed consistent with the prevailing barite dam construction practice. This method consists of a clay starter dam enlarged using minus 7/8-inch gravel.

(7) Cutoff - There is no written information available to indicate that a cutoff was designed or constructed. Verbal information indicates that a cutoff was built, but this information could not be verified.

i. Spillway. There is no constructed spillway for Black Tailings Dam. An open channel spillway connects the tailings pond with the upstream pond.

j. Outlet. Note that this pipe is considered to be nonfunctional. It is an abandoned water supply line.

(1) Length - unknown.

(2) Invert of 6-inch Pipe at Upstream End - El. 902.0 feet.

(3) Invert of Pipe at Downstream End - unknown.

(4) Type - 6 inch diameter steel pipe.

(5) Shape of Entrance - approximately vertical riser pipe (square edges).

(6) Slope - unknown.

(7) Flow at Time of Inspection - unknown.

k. Diversion Ditches. Not applicable.

## SECTION 2 - ENGINEERING DATA

### 2.1 DESIGN

No design drawings or data are known to exist.

### 2.2 CONSTRUCTION

a. Information. The dam was built in 1942 and 1943 by the Cadet Mining Company. There are no records concerning construction methods, materials, or procedures.

Mr. Sy Williams, caretaker of the property on which the dam is sited, and former mine employee, provided information concerning the construction and enlargement of the dam. The ground was stripped of vegetation, and a foundation trench was excavated for half the width of the dam section to a variable depth. The trench was backfilled by cable scrapers with residual soil that was obtained from the core trench excavation. The embankment was initially constructed to a height of 20 to 25 feet with a crest width of about 25 feet. The dam was enlarged during mining operations by end-dumping coarse tailings up to 7/8-inch in diameter and expanding the crest width 3 to 4 feet. The crest was then raised 1 foot with tailings, and the end-dumping procedure was repeated until the dam was raised to the necessary height. The gravels were not compacted except by the movement of hauling and construction equipment during placing and hauling operations.

b. Assessment of Construction Method and Materials. Procedures used to build this dam were developed by miners over the last 60 years. After construction of the starter dam, sand and angular gravels (finer than 7/8-inch) were hauled to the crest of the dam, end-dumped, and spread; and excess material was pushed over the upstream and downstream faces of the dam. The sands and gravels placed in this manner are in a loose state and are at their natural angle of repose on the downstream face. The material pushed over the upstream side rests on the tailings. The centerline of the dam remains approximately at the same position as the embankment is raised. Compaction of the material on the crest was by construction equipment.

The minus 7/8-inch gravels were used to enlarge this tailings dam. They are free draining, angular, and relatively well-graded through the gravel and coarse sand range. The gravel appears to function well as a drain material, and it also functions fairly well as erosion protection from rainfall; however, it is inadequate to prevent erosion from channeled surface flow with a velocity greater than 4 to 6 feet per second.

There are buried trees extending above the downstream face, which are apparently rooted in the dam's foundation. This would indicate that foundation preparation for the downstream foundation zone appears to be nonexistent.

## 2.3 OPERATION

The impoundment was operated from 1942 by Cadet Mining Company and subsequently by J. E. Carter Company until 1953. No records of operation are known to exist.

## 2.4 EVALUATION

a. Availability. No design or construction records were available. The only information made available to the inspection team was provided during conversations with the caretaker of the property who described his recollection of construction and operation of the dam.

b. Adequacy. The field survey and visual inspection documented herein are considered adequate to support the conclusions of this report. Seepage and stability analyses comparable to the requirements of "Recommended Guidelines for the Safety Inspection of Dams" are not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions, including earthquake loads, and made a matter of record.

c. Validity. Not applicable.

## SECTION 3 - VISUAL INSPECTION

### 3.1 FINDINGS

a. General. The inspection team consisted of a civil engineer and an engineering geologist from International Engineering Company, Inc. The owners, Mr. and Mrs. Ray Black, gave verbal authorization by telephone for the inspection team to visit the site. The inspection team was met at the site by Mr. Sy Williams, the property caretaker.

Photographs taken during the inspection are included in this report. Photograph locations are shown on Plate 6.

b. Project Geology. Bedrock in the area and underlying the dam is composed of the gray dolomite of the Cambrian age Potosi formation. Isolated outcrops are found over much of the surrounding area. These outcrops have been exposed by mining activities. Soil cover ranges up to 15 feet in thickness; the overburden soil is residual dark red and brown barite rich clays. The barite occurs within the residual clays as irregularly scattered fragments. Also intermixed are fragments of quartz, druse, chert and dolomite which range in size from sand to boulders.

c. Dam. The plan of the dam is shown on Plate 3. The profile and cross-section are shown on Plates 4 and 5. Some brush and small trees are growing on the downstream slope, and a few larger trees are present at the downstream toe. The upstream slope is covered with grass, vines, brush, and small trees.

No cracking, detrimental settlement, depressions, sinkholes, animal burrows, or conclusive evidence of past embankment overtopping was observed. The materials on the downstream slope appear to be near their angle of repose.

Two notches caused by erosion drain the crest into the tailings at Stations 12+53 and 13+15. Erosion on the downstream slope was observed at Station 4+57. This may be caused in part by motorcycle traffic.

Two springs and a pool were observed at the downstream toe of the dam (see Plate 3). Spring No. 1 at Station 11+17 was flowing clear at about 1 gpm from the base of the dam through talus lying on natural ground. Spring No. 2 at Station 13+68 was flowing clear from the toe of the dam at a rate of about 20 gpm. The ground is soft and saturated near each spring and around the pool. The pool is located at Station 9+00 and has a surface area of about 2400 square feet (0.05 acre) and an average water depth of two feet. The pool has apparently resulted from accumulated seepage from the toe, although no flow directly into the pool from the dam was observed.

The toe of the dam from Stations 5+50 to 13+00 is located on the floodplain of the East Branch of Mill Creek.

The difference in height between the effective crest elevation and the adjacent tailings elevation varies between approximately 1.5 feet at Station 2+10 at the left abutment to 6.5 feet along the crest.

The embankment crest has a low point near Station 2+10 that could function as an overflow, although there was no clear evidence of past flow from the dam. The low point is located at the approximate left abutment-embankment contact. Both abutments consist of residual gravelly clay. The left abutment has been strip-mined. No mining activity has occurred at the right abutment.

d. Appurtenant Structures. No operable spillway, diversion ditch, or defined downstream drainage channel was located. Two old spillways near the right abutment were buried during the dam enlargement process. A low spot on the crest at Station 2+10 at the left abutment would serve as an overflow section. Water from the dam would probably flow over the crest road at Station 2+10, down a 10 foot high embankment into a strip-mined area away from the embankment toe.

An outlet pipe was found at this site. A vertical 6-inch water supply pipe was located at Station 4+30; this pipe is 4.5 feet higher than the low point on the crest profile. This pipe is considered to be nonfunctional. No outlet for this pipe was located. It was used to conduct water to the mill from Mill Creek.

e. Reservoir Area. No evidence of landslides along the shoreline was observed. The topography of the drainage basin is of low relief. Some minor erosion was noted at the mined out areas.

A large portion of the drainage basin has been excavated by shallow surface mining, and these activities may result in some sedimentation.

The impoundment consists of red silty clays deposited by hydraulic methods during active mine operations. No deposition has occurred for approximately 26 years. Some consolidation of the tailings has probably occurred, primarily in the immediate area adjacent to the dam where drainage can occur. Also the surface zones have dessicated and small trees and grasses transpire some water from near the surface of the tailings.

Several relatively small ponds lie upstream of the impoundment in the watershed. The largest pond lies immediately upstream of the impoundment. It is connected to the tailings impoundment by an excavated spillway channel.

No structures were found that would be endangered by backwater flooding.

Approximately 35 percent of the watershed area is covered with undisturbed forest. About 50 percent of the area has been excavated by mining, which has disrupted natural drainage and caused the formation of a number of water ponds. Approximately 15 percent of the watershed consists of tailings and water ponds.

f. Downstream Channels. The tailings dam is situated on a small sidehill drainage that is tributary to the East Branch of Mill Creek. No defined channel downstream of the likely overflow was located. Water from the dam would probably flow over the crest road at Station 2+10, down a 10 foot high embankment section and away from the embankment toe into a strip-mined area and then into East Branch of Mill Creek.

## 3.2 EVALUATION

Seepage, a pool of water, interrupted drainage, and soft, marshy ground was observed at the dam toe for approximately 300 feet. This area is on the Mill Creek floodplain. No adequate means of draining this water was evident. This condition could weaken the foundation clay soil by saturation and adversely affect the stability of the dam.

No functional spillway was observed. The outlet pipe located was incapable of passing impounded water. The lack of a spillway increases the likelihood of overtopping the crest road at the left abutment, where the low point of the dam is located.

## SECTION 4 - OPERATIONAL PROCEDURES

### 4.1 PROCEDURES

No regulating procedures are in effect at this site. No means of passing runoff water has been provided for this dam.

### 4.2 MAINTENANCE OF DAM

Information available to the inspection team indicates that the dam is not maintained.

### 4.3 MAINTENANCE OF OPERATING FACILITIES

Not applicable.

### 4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no warning system in effect at this dam.

### 4.5 EVALUATION

An inspection program should be initiated so that indications of instability, such as cracks in the dam, sloughing, sudden settlement, erosion of the dam, or an increase in the volume or turbidity of seepage water, can be monitored.

## SECTION 5 - HYDRAULIC AND HYDROLOGIC ANALYSES

### 5.1 EVALUATION OF FEATURES

a. Design Data. The significant dimensions of the dam are presented in Section I - Project Information, and also presented in the accompanying field survey drawings, Plates 3 through 5. Hydrologic or hydraulic design information are not available.

The watershed drainage area and stream lengths were measured from the 1958 7-1/2-minute USGS Mineral Point Quadrangle, Missouri, which has 20-foot contour intervals. Reservoir areas were measured using a 1971 air photograph enlargement. The soil group for this watershed is classified as Clarksville Gravelly Lo a hydrologic soil group B classification, which has a moderate rate of water transmission.

The total drainage area at Black Tailings Dam, Mo., I.D. No. 31154, is about 260 acres (0.466 square miles). The watershed location and drainage boundary are shown on Plate 2. There is another pond immediately upstream of the tailings pond defined by two parallel dikes. The entire watershed can be subdivided into two parts: upper watershed above dikes (222 acres), and local drainage area above the Black Tailings Dam, I.D. No. 31154 (38 acres).

Land use and vegetation pattern on the watershed were determined from field observations and aerial photographs of the area. The type of land cover and land use were used to estimate runoff curve numbers (CN) for the antecendent moisture conditions (AMC), which in turn, determine the amount of infiltration, retention losses and net runoff.

The design data, information, and assumptions used in the hydrologic and hydraulic analyses for each subarea are individually discussed below. Basin parameters such as lag time, unit hydrograph, probable maximum precipitation, losses and net runoff for each subarea are shown in Appendix A.

Subarea 1 - Upper Watershed Above Dikes

This is the area upstream of the dike that forms the west end of the upstream pond. The total drainage area is about 222 acres (0.347 square miles). Land use and type of land cover within Subarea 1 are as follows:

| Type of Cover | Percent of Area |
|---|---|
| Woodlands | 36 |
| Old Mined Areas | 58 |
| Pond | 6 |

The estimated runoff curve numbers (CN), weighted according to the above land distribution, are AMC II, CN 49 and AMC III, CN 70.

A road has cut across the upper watershed on the south and the east parts of the drainage area. It was assumed that the storage effect of the road embankment is small and the travel time of the flood flowing to the upstream pond will not be significantly affected.

The dike defining the east boundary of the upstream pond contains a large (about 30 feet wide at the bottom) breach. This breach was assumed to have no significant effect on travel time of the flood.

A spillway channel, approximately 400 feet long, is located on the north end of the lower dike diverting water to the main tailings pond. The invert elevation at the entrance of the spillway is El. 900.0. The spillway rating curve was derived by the Manning equation, using a Manning's "n" of 0.04, and a channel bottom slope of 0.01 as determined approximately from the field investigations.

Discharge rating curve for flow over the top of the dike (El. 904.5) was computed by the weir formula using a weir discharge coefficient of 2.7. The length of the dike is approximately 800 feet long. The combined discharge rating curve for flows over spillway and dike is shown in Appendix A, under the input data listing as Y4 and Y5 cards for the upstream pond, and also in the computer printout.

The upstream pond water surface area at El. 900 is estimated to be about 7 acres. The water surface areas at other elevations were estimated from field investigations. The relative capacities of the pond at each elevation above El. 900 were computed by the conic method in the computer program. The reservoir elevation-area-capacity data are also shown in the computer printout of Appendix A.

Subarea 2 - Black Tailings Dam

This subarea is the drainage area between the lower dike of the upstream pond and the Black Tailings Dam. The total drainage area is about 38 acres (0.059 square miles). There is no outflow structure provided, and the tailing dam constitutes a closed system. About 68 percent of the subarea is the pond area with water and tailings, and the rest of the area is covered with woodlands. A lag time of 5 minutes, and a runoff curve number of 100 were assumed for the computations of flood runoff for this Subarea.

The discharge rating curve for flow over the dam crest (El. 897.7) was computed by the weir formula using a weir coefficient of 2.7. A representative overflow cross-section from Station 0+00 to Station 6+00 was used based on the field survey data available. The discharge rating curve is shown in Appendix A as Y4 and Y5 cards of the input data listing.

The reservoir area-elevation relationship was derived based on the approximate contours drawn on the aerial photographs. It was assumed that the tailings pond bottom is at El. 893. The relative capacities of the pond at various water surface elevations above El. 893 were also computed

in the computer program by the Conic Method. The reservoir elevation-area-capacity data are shown in Appendix A.

b. Experience Data. Rainfall, streamflow and flood data for the entire watershed are not available.

c. Visual Observations. Visual observations are presented in Section 3 - Visual Observations.

d. Overtopping Potential. The following steps were used to analyze the flow regime, flood magnitudes, flood volumes and the overtopping potential at the Black Tailings Dam:

- Compute and route floods for Subarea 1 - Upper Watershed Above Dikes.
- Compute floods for Subarea 2 - Black Tailings Dam.
- Combine the routed outflows from Subarea 1 with the computed floods for Subarea 2 to obtain the total inflows to the project reservoir at Black Tailings Dam.
- Route the total inflows through project reservoir to determine overtopping potential.

The 10-year and 100-year floods, the probable maximum flood (PMF) and floods expressed as a percent of the PMF, were individually computed following the steps described above. The probable maximum flood is defined as the hypothetical flood event that would result from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible at a particular location or region.

The Modified Puls Method was used to route floods through the upstream pond and the project reservoir. For all cases of the flood routing, the starting water surface elevation of the upstream pond was set at spillway invert elevation (El. 900). Initial level of the main tailings pond was set at the highest existing water surface elevation observed, El. 896.9.

Results of the routing computations showed that the main tailings pond of the Black Dam will not be able to contain the 10-year flood without overtopping the low point of the dam at the left abutment (El. 897.7). Routing studies of floods expressed as percentage of the PMF indicated that the dam will be overtopped at approxmiately 3 percent of the PMF. Separate hydrologic and hydraulic analyses of the upstream pond showed that the flow velocity of the spillway channel will be 5 feet per second (maximum permissible) at about 11 percent PMF, and the dike will be overtopped at about 26 percent PMF. These indicate that the upstream dike is safe when the Black Tailing Dam is overtopped at 3 percent PMF. The maximum permissible velocity of 5 feet per second for the spillway channel was based on the criteria of the Corps of Engineers Manual EM 1110-2-1601, "Hydraulic Design of the Flood Control Channels".

The primary effect of overtopping would be the discharge of water down a 10 foot high embankment into the strip mined area southwest of the dam. Information from field investigations indicate that the water would probably flow away from the embankment toe. Significant erosion and movement of embankment material at the overtopping section could occur with high sustained overtopping discharges.

Results of the overtopping analyses are reported in Appendix A and summarized in the following table.

| | Upstream Dike | | | | Downstream Tailings Dam | | | |
|---|---|---|---|---|---|---|---|---|
| Flood | Peak Inflow (cfs) | Peak Outflow (cfs) | Max. Res. WS Elev. (ft) | Spillway Velocity (fps) | Peak Inflow (cfs) | Peak Outflow (cfs) | Max. Res. WS Elev. (ft) | Duration Over Top (hr) |
| 10-Year | 59 | 17 | 901.1 | 3.0 | 168 | 22 | 898.0** | 12 |
| 100-Year | 147 | 52 | 902.0 | 4.1 | 241 | 69 | 898.2** | 12.2 |
| 2% PMF | 37 | 10 | 900.7 | 2.3 | 22 | 0 | 897.6 | 0 |
| 3% PMF | 56 | 15 | 901 | 2.8 | 33 | 8 | 897.8** | 4.0 |
| 25% PMF | 463 | 259 | 904.4 | 6.2* | 327 | 281 | 898.7** | 11.2 |
| 30% PMF | 556 | 445 | 904.7*** | 6.5* | 489 | 391 | 898.9** | 11.6 |
| 50% PMF | 926 | 905 | 905.0*** | 6.8* | 981 | 890 | 899.6** | 13.5 |
| PMF | 1852 | 1827 | 905.3*** | 7.0* | 1991 | 1843 | 900.5** | 15.9 |

* These velocities are considered to produce the effects of significant erosion.

** Dam overtopped (Minimum Dam Crest, El. 897.7).

*** Dike overtopped (Minimum Dike Crest, El. 904.5).

Note: Reservoir water surface elevations include the velocity heads corresponding to the velocities computed at various flow depths for the spillway section and section over the minimum dam crest or dike crest.

## SECTION 6 - STRUCTURAL STABILITY

### 6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visual observations of conditions that may adversely affect the structural stability of this dam are discussed in Section 3.

b. Design and Construction Data. No design or construction data pertaining to the structural stability of the dam were available. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, and lack of this information is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions, including earthquake loads, and made a matter of record.

c. Operating Records. No appurtenant structures are operable at this dam; no records of operations were located.

d. Post-Construction Changes. The dam has been enlarged during active mine operations, but no written records are available concerning dates of enlargements, design, or materials used.

e. Seismic Stability. The dam is located in seismic Zone 3, to which the 1976 Uniform Building Code assigns a "moderate" damage potential. There appears to be a potential for instability caused by ground shaking during earthquakes where the dam overlies soft saturated clay foundation soil. Some crest settlement and ravelling of the embankment gravels could also occur during seismic shaking because the downstream slope is at or near the natural angle of repose of the gravel.

## SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

### 7.1 DAM ASSESSMENT

a. Safety. Several deficient conditions at the dam should be corrected to improve the margin of safety. The absence of an operable spillway to remove storm runoff is the most serious deficiency. The other deficiency noted is soft foundation materials resulting from ponded seepage and springs at the dam toe. The soft foundation conditions caused by seepage could adversely affect the stability of the dam. Suggested remedial measures are discussed in Section 7.2 REMEDIAL MEASURES.

b. Adequacy of Information. No design or construction data were available. Seepage and stability analyses meeting the requirements of "Recommended Guidelines for the Safety Inspection of Dams" were not available, which is considered a deficiency.

Topographic data for this dam is inadequate. This is due to relief detail being omitted in strip mined areas and some mining activity occurred subsequent to the publication of the map. The drainage area measurement was made on the original topography. Reservoir area capacity data and slopes were developed using survey measurements and constructing topographic contours on a 1"=660' air photo enlargements showing the reservoir and watershed areas. This data is considered adequate for a Phase I analysis; however, the evaluation of overtopping potential is approximate due to the available data.

c. Urgency. The lack of a spillway is a serious deficiency. This condition should be corrected without delay.

d. Necessity for Phase II. Additional studies are not recommended for this dam, with the exception of seepage and stability analyses or a reclamation plan as described below in Section 7.2.

### 7.2 REMEDIAL MEASURES

a. Spillway. A spillway should be designed to safely pass the PMF without causing erosion of the embankment under the Guidelines established by the Corps of Engineers. An engineer experienced in the design of tailings dams should be retained to design and direct construction of the spillway.

b. Drainage of Seepage. Seepage which presently ponds at the dam toe in various locations between Stations 7+50 and 11+00 should be drained to remove water which saturates and weakens foundation soil.

d. Inspection Program. The dam should be inspected periodically by an engineer who will observe and record the performance of the dam. The springs and seeps should be monitored as part of the inspection program. Records of these inspections should be maintained, and all maintenance or remedial measures performed at the site should be documented.

e. Stability and Seepage Analyses should be performed by an engineer experienced in the design and construction of tailings dams. The embankment is a relatively porous granular structure above the tailings surface. If the impoundment water level were to rise above the tailings surface, there could be significant seepage through the embankment which could adversely affect the stability of the dam. Included in these analyses, therefore, seepage and stability computations should also be performed with the reservoir water surface set at the top of the dam. Based on the results of these studies, remedial measures may be necessary. Remedial work should be done under the direction of an engineer experienced in tailings dam design and construction.

f. Deactivation of Impoundment. As an alternative to the above measures, a plan to permanently drain the impoundment and reclaim the embankment and tailings pond could be developed. Such a plan should make provisions for the safe removal of storm runoff and maintain the stability of the dam and impounded tailings at all times. Preparation of a reclamation plan and reclamation activities should be accomplished under the direction of an engineer experienced in the design and construction of tailings dams.

# APPENDIX A

# HYDROLOGIC AND HYDRAULIC ANALYSES

# APPENDIX A

## HYDROLOGIC AND HYDRAULIC ANALYSES

The hydrologic and hydraulic analyses were accomplished by using the computer program "Flood Hydrograph Package, HEC-1, Dam Safety Investigations Version, July 1978". This program was developed by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. The criteria and methodology used are briefly discussed below:

- Probable Maximum Precipitation (PMP) - The 24-hour PMP was obtained from Hydrometeorological Report No. 33. The 6-hour and the 1-hour depth-duration distributions followed Corps of Engineers EM 1110-2-1411 criteria.

- 100-year and/or 10-year storms - The 24-hour storm amounts and distributions were supplied by Corps of Engineers, St. Louis District, Missouri.

- Unit Hydrograph - The Soil Conservation Service (SCS) curvelinear unit hydrograph method was used. Basin lag time was computed by using the SCS Curve Number Method and equation.

- Hydrologic Soil Group, Antecedent Moisture Condition (AMC) and Curve Number (CN) - The predominant hydrologic soil group for the watershed was obtained from an agricultural soil classification map prepared by the University of Missouri Agricultural Experiment Station. For the PMF and floods expressed as a percent of PMF, AMC III conditions were used. For the 100-year and/or 10-year floods, AMC II conditions were assumed. Watershed CN was estimated from field observations and from aerial photos.

- Reservoir Area-Capacity - Areas were measured from A.S.C.S. air photograph enlargements. Reservoir elevations and corresponding surface areas were input into the computer program, which determined the reservoir capacities by the Conic Method.

- Reservoir and Spillway Flood Routing - The Modified Puls Method was used for all flood routing through spillway and dam overtopping analyses.

The following pages present the input data listing, the computer program version and its last modification date, together with pertinent computer printouts of results. Definitions of all input and output variable names are presented in the computer program "Users Manual", September 1978, and are not explained herein.

```
A1          BLACK DAM, ID. NO. 31154
A2          HEC-1  PHASE 1 DAM SAFETY INVESTIGATION
A3          RATIOS OF PMF
B     288                     5
B1      5
J       1           0           1
J1    .02         .03         .25         .30         .50         1.0
K       0   INFLOW                                      1           1
K1    PMF INFLOW, RUNOFF FROM UPPER WATERSHED
M       1           2       .3469
P       0        20.5         102         120         130                                 -1         -68                     .00
T
W2                  .59
X     -10         -.1         2.5                                                 1           1
K       1   POND 1
K1    ROUTING THROUGH SPILLWAY
Y                                                   1           1                   -900          -1
Y1      1                                                                           904.6       905.0       905.5       906.5
Y4  900.0       901.0       902.0       903.0       904.0       904.5       905     980         2210        5720
Y5      0          15          54         115         208         270         350
$A      5           7           9          10          11          12          14
$E    897         900       902.3       903.3       904.2         905       906.4
$S    900
$D  904.5
```

```
K       0  INFLOW                                                1       1
K1    RUNOFF FROM LOWER WATERSHED
M       1       2    .0594                                       1                       1
P       0    26.5     102      120      130
T                                                                        -1     -100
W2              .1
X    -.01    -.01      1.0
K       2  UP+LOW                                                1       1
K1    COMBINATION OF OUTFLOW FROM UPPER DIKE AND RUNOFF FROM LOWER WATERSHED
K       1  POND 2                                                1       1
K1    ROUTING THROUGH LAKE, CLOSED SYSTEM
Y                                       1       1
Y1      1                                                  -896.9      -1
Y4  897.7   898.0   898.5   899.0   899.5   900.0
Y5      0      25     165     425     825    1350
$A      0       3      10      14      18      22
$E    893     895     897     898     899     900
$$  897.7
$D  897.7
K      99
A
A
A
A
A
```

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION        JULY 1978
  LAST MODIFICATION  26 FEB 79
**********

RUN  DATE= 79/04/15.
     TIME= 13.20.34.
```

BLACK DAM, ID, NO. 31154
HEC-1 PHASE 1 DAM SAFETY INVESTIGATION
RATIOS OF PMF

JOB SPECIFICATION

| NO | NRD | NMIN | IDAY | IHR | IMIN | METRC | IPLT | IPRT | NSTAN |
|---|---|---|---|---|---|---|---|---|---|
| 200 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | JOPER | NWT | LROPT | TRACE | | | |
| | | | 5 | 0 | 0 | 0 | | | |

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 6 LRTIO= 1
RTIOS= .67 .83 .25 .30 .50 1.00

********** *********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

PMF INFLOW, RUNOFF FROM UPPER WATERSHED

| | ISTAO | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|---|
| INFLOW | | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |

HYDROGRAPH DATA

| IHYDG | IUHG | TAREA | SNAP | TRSDA | TRSPC | RATIO | ISNOW | ISAME | LOCAL |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | .35 | 0.00 | .35 | 0.00 | 0.000 | 0 | 0 | 0 |

PRECIP DATA

| JPRE | PB5 | PB6 | PB12 | PB24 | PB48 | PB72 | PB96 |
|---|---|---|---|---|---|---|---|
| 0.00 | 26.50 | 102.00 | 120.00 | 130.00 | 0.00 | 0.00 | 0.00 |

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

| LROPT | STRKR | DLTKR | RTIOL | ERAIN | STRKS | RTIOK | STRTL | CNSTL | ALSMX | RTIMP |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | 1.00 | -1.00 | -68.00 | 0.00 | .06 |

STRKR + DLTKR = -68.00 WETNESS = -1.00 EFFECT CN = 68.00

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= .59

RECESSION DATA
STRTQ= -10.00 QRCSN= -.10 RTIOR= 2.50

UNIT HYDROGRAPH 37 END-OF-PERIOD ORDINATES, TC= 0.00 HR, LAG= .59 VOL= 1.00
14. 82. 81. 15. 200. 244. 265. 268. 249. 224.

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 193. | 154. | 119. | 99. | 77. | 64. | 52. | 41. | 33. | 27. | | | |
| | 22. | 17. | 14. | 11. | 9. | 7. | 6. | 5. | 4. | 3. | | | |
| | 3. | 2. | 2. | 1. | 1. | 1. | 0. | | | | | | |

END-OF-PERIOD FLOW

| HYDRO | HYDRO | PERIOD | RAIN | EXCS | LOSS | COMP Q | HYDRO | HYDRO | PERIOD | RAIN | EXCS | LOSS | COMP Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.01 | .05 | 1 | .01 | .00 | .01 | 3. | 1.01 | 12.05 | 145 | .18 | .13 | .05 | 97. |
| 1.01 | .10 | 2 | .01 | .00 | .01 | 3. | 1.01 | 12.10 | 146 | .18 | .13 | .05 | 101. |
| 1.01 | .15 | 3 | .01 | .00 | .01 | 3. | 1.01 | 12.15 | 147 | .18 | .13 | .05 | 109. |
| 1.01 | .20 | 4 | .01 | .00 | .01 | 3. | 1.01 | 12.20 | 148 | .18 | .13 | .05 | 123. |
| 1.01 | .25 | 5 | .01 | .00 | .01 | 3. | 1.01 | 12.25 | 149 | .18 | .14 | .04 | 142. |
| 1.01 | .30 | 6 | .01 | .00 | .01 | 3. | 1.01 | 12.30 | 150 | .18 | .14 | .04 | 166. |
| 1.01 | .35 | 7 | .01 | .00 | .01 | 3. | 1.01 | 12.35 | 151 | .18 | .14 | .04 | 192. |
| 1.01 | .40 | 8 | .01 | .00 | .01 | 3. | 1.01 | 12.40 | 152 | .18 | .14 | .04 | 218. |
| 1.01 | .45 | 9 | .01 | .00 | .01 | 3. | 1.01 | 12.45 | 153 | .18 | .14 | .04 | 243. |
| 1.01 | .50 | 10 | .01 | .00 | .01 | 3. | 1.01 | 12.50 | 154 | .18 | .14 | .04 | 267. |
| 1.01 | .55 | 11 | .01 | .00 | .01 | 3. | 1.01 | 12.55 | 155 | .18 | .14 | .04 | 287. |
| 1.01 | 1.00 | 12 | .01 | .00 | .01 | 3. | 1.01 | 13.00 | 156 | .18 | .15 | .03 | 305. |
| 1.01 | 1.05 | 13 | .01 | .00 | .01 | 3. | 1.01 | 13.05 | 157 | .22 | .18 | .04 | 320. |
| 1.01 | 1.10 | 14 | .01 | .00 | .01 | 3. | 1.01 | 13.10 | 158 | .22 | .18 | .04 | 333. |
| 1.01 | 1.15 | 15 | .01 | .00 | .01 | 3. | 1.01 | 13.15 | 159 | .22 | .18 | .04 | 346. |
| 1.01 | 1.20 | 16 | .01 | .00 | .01 | 3. | 1.01 | 13.20 | 160 | .22 | .18 | .03 | 360. |
| 1.01 | 1.25 | 17 | .01 | .00 | .01 | 2. | 1.01 | 13.25 | 161 | .22 | .18 | .03 | 374. |
| 1.01 | 1.30 | 18 | .01 | .00 | .01 | 2. | 1.01 | 13.30 | 162 | .22 | .18 | .03 | 388. |
| 1.01 | 1.35 | 19 | .01 | .00 | .01 | 2. | 1.01 | 13.35 | 163 | .22 | .18 | .03 | 403. |
| 1.01 | 1.40 | 20 | .01 | .00 | .01 | 2. | 1.01 | 13.40 | 164 | .22 | .19 | .03 | 417. |
| 1.01 | 1.45 | 21 | .01 | .00 | .01 | 2. | 1.01 | 13.45 | 165 | .22 | .19 | .03 | 430. |
| 1.01 | 1.50 | 22 | .01 | .00 | .01 | 2. | 1.01 | 13.50 | 166 | .22 | .19 | .03 | 441. |
| 1.01 | 1.55 | 23 | .01 | .00 | .01 | 2. | 1.01 | 13.55 | 167 | .22 | .19 | .03 | 452. |
| 1.01 | 2.00 | 24 | .01 | .00 | .01 | 2. | 1.01 | 14.00 | 168 | .22 | .19 | .03 | 461. |
| 1.01 | 2.05 | 25 | .01 | .00 | .01 | 2. | 1.01 | 14.05 | 169 | .27 | .24 | .03 | 469. |
| 1.01 | 2.10 | 26 | .01 | .00 | .01 | 2. | 1.01 | 14.10 | 170 | .27 | .24 | .03 | 478. |
| 1.01 | 2.15 | 27 | .01 | .00 | .01 | 2. | 1.01 | 14.15 | 171 | .27 | .24 | .03 | 488. |
| 1.01 | 2.20 | 28 | .01 | .00 | .01 | 2. | 1.01 | 14.20 | 172 | .27 | .24 | .03 | 500. |
| 1.01 | 2.25 | 29 | .01 | .00 | .01 | 2. | 1.01 | 14.25 | 173 | .27 | .24 | .03 | 514. |
| 1.01 | 2.30 | 30 | .01 | .00 | .01 | 2. | 1.01 | 14.30 | 174 | .27 | .24 | .03 | 530. |
| 1.01 | 2.35 | 31 | .01 | .00 | .01 | 2. | 1.01 | 14.35 | 175 | .27 | .25 | .03 | 547. |
| 1.01 | 2.40 | 32 | .01 | .00 | .01 | 2. | 1.01 | 14.40 | 176 | .27 | .25 | .02 | 564. |
| 1.01 | 2.45 | 33 | .01 | .00 | .01 | 2. | 1.01 | 14.45 | 177 | .27 | .25 | .02 | 579. |
| 1.01 | 2.50 | 34 | .01 | .00 | .01 | 2. | 1.01 | 14.50 | 178 | .27 | .25 | .02 | 593. |
| 1.01 | 2.55 | 35 | .01 | .00 | .01 | 2. | 1.01 | 14.55 | 179 | .27 | .25 | .02 | 606. |
| 1.01 | 3.00 | 36 | .01 | .00 | .01 | 2. | 1.01 | 15.00 | 180 | .27 | .25 | .02 | 619. |
| 1.01 | 3.05 | 37 | .01 | .00 | .01 | 2. | 1.01 | 15.05 | 181 | .16 | .15 | .01 | 628. |
| 1.01 | 3.10 | 38 | .01 | .00 | .01 | 2. | 1.01 | 15.10 | 182 | .33 | .30 | .02 | 629. |
| 1.01 | 3.15 | 39 | .01 | .00 | .01 | 2. | 1.01 | 15.15 | 183 | .33 | .31 | .02 | 634. |
| 1.01 | 3.20 | 40 | .01 | .00 | .01 | 2. | 1.01 | 15.20 | 184 | .49 | .46 | .03 | 640. |
| 1.01 | 3.25 | 41 | .01 | .00 | .01 | 2. | 1.01 | 15.25 | 185 | .58 | .54 | .04 | 654. |
| 1.01 | 3.30 | 42 | .01 | .00 | .01 | 2. | 1.01 | 15.30 | 186 | 1.40 | 1.32 | .08 | 691. |
| 1.01 | 3.35 | 43 | .01 | .00 | .01 | 2. | 1.01 | 15.35 | 187 | 2.30 | 2.19 | .11 | 779. |
| 1.01 | 3.40 | 44 | .01 | .00 | .01 | 2. | 1.01 | 15.40 | 188 | .90 | .87 | .04 | 919. |
| 1.01 | 3.45 | 45 | .01 | .00 | .01 | 2. | 1.01 | 15.45 | 189 | .58 | .55 | .02 | 1110. |
| 1.01 | 3.50 | 46 | .01 | .00 | .01 | 2. | 1.01 | 15.50 | 190 | .49 | .47 | .02 | 1344. |
| 1.01 | 3.55 | 47 | .01 | .00 | .01 | 2. | 1.01 | 15.55 | 191 | .33 | .32 | .01 | 1573. |
| 1.01 | 4.00 | 48 | .01 | .00 | .01 | 2. | 1.01 | 16.00 | 192 | .33 | .32 | .01 | 1745. |
| 1.01 | 4.05 | 49 | .01 | .00 | .01 | 2. | 1.01 | 16.05 | 193 | .25 | .24 | .01 | 1837. |
| 1.01 | 4.10 | 50 | .01 | .00 | .01 | 2. | 1.01 | 16.10 | 194 | .25 | .24 | .01 | 1852. |
| 1.01 | 4.15 | 51 | .01 | .00 | .01 | 2. | 1.01 | 16.15 | 195 | .25 | .24 | .01 | 1802. |
| 1.01 | 4.20 | 52 | .01 | .00 | .01 | 2. | 1.01 | 16.20 | 196 | .25 | .24 | .01 | 1704. |
| 1.01 | 4.25 | 53 | .01 | .00 | .01 | 2. | 1.01 | 16.25 | 197 | .25 | .24 | .01 | 1570. |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.01 | 4.30 | 54 | .01 | .00 | .01 | 2. | 1.01 | 16.30 | 198 | .25 | .24 | .01 | 1816. |
| 1.01 | 4.35 | 55 | .01 | .00 | .01 | 2. | 1.01 | 16.35 | 199 | .25 | .24 | .01 | 1274. |
| 1.01 | 4.40 | 56 | .01 | .00 | .01 | 2. | 1.01 | 16.40 | 200 | .25 | .24 | .01 | 1158. |
| 1.01 | 4.45 | 57 | .01 | .00 | .01 | 2. | 1.01 | 16.45 | 201 | .25 | .24 | .01 | 1062. |
| 1.01 | 4.50 | 58 | .01 | .00 | .01 | 2. | 1.01 | 16.50 | 202 | .25 | .25 | .01 | 986. |
| 1.01 | 4.55 | 59 | .01 | .00 | .01 | 2. | 1.01 | 16.55 | 203 | .25 | .25 | .01 | 922. |
| 1.01 | 5.00 | 60 | .01 | .00 | .01 | 2. | 1.01 | 17.00 | 204 | .25 | .25 | .01 | 870. |
| 1.01 | 5.05 | 61 | .01 | .00 | .01 | 2. | 1.01 | 17.05 | 205 | .20 | .19 | .01 | 829. |
| 1.01 | 5.10 | 62 | .01 | .00 | .01 | 2. | 1.01 | 17.10 | 206 | .20 | .19 | .01 | 794. |
| 1.01 | 5.15 | 63 | .01 | .00 | .01 | 2. | 1.01 | 17.15 | 207 | .20 | .19 | .01 | 762. |
| 1.01 | 5.20 | 64 | .01 | .00 | .01 | 2. | 1.01 | 17.20 | 208 | .20 | .19 | .01 | 734. |
| 1.01 | 5.25 | 65 | .01 | .00 | .01 | 2. | 1.01 | 17.25 | 209 | .20 | .19 | .01 | 705. |
| 1.01 | 5.30 | 66 | .01 | .00 | .01 | 2. | 1.01 | 17.30 | 210 | .20 | .19 | .00 | 679. |
| 1.01 | 5.35 | 67 | .01 | .00 | .01 | 2. | 1.01 | 17.35 | 211 | .20 | .19 | .00 | 654. |
| 1.01 | 5.40 | 68 | .01 | .00 | .01 | 2. | 1.01 | 17.40 | 212 | .20 | .19 | .00 | 631. |
| 1.01 | 5.45 | 69 | .01 | .00 | .01 | 2 | 1.01 | 17.45 | 213 | .20 | .19 | .00 | 611. |
| 1.01 | 5.50 | 70 | .01 | .00 | .01 | 2. | 1.01 | 17.50 | 214 | .20 | .19 | .00 | 594. |
| 1.01 | 5.55 | 71 | .01 | .00 | .01 | 2. | 1.01 | 17.55 | 215 | .20 | .19 | .00 | 579. |
| 1.01 | 5.60 | 72 | .01 | .00 | .01 | 2. | 1.01 | 18.00 | 216 | .20 | .19 | .00 | 567. |
| 1.01 | 6.05 | 73 | .05 | .00 | .05 | 2. | 1.01 | 18.05 | 217 | .02 | .02 | .00 | 556. |
| 1.01 | 6.10 | 74 | .05 | .00 | .05 | 2. | 1.01 | 18.10 | 218 | .02 | .02 | .00 | 541. |
| 1.01 | 6.15 | 75 | .05 | .00 | .05 | 2. | 1.01 | 18.15 | 219 | .02 | .02 | .00 | 521. |
| 1.01 | 6.20 | 76 | .05 | .01 | .05 | 3. | 1.01 | 18.20 | 220 | .02 | .02 | .00 | 491. |
| 1.01 | 6.25 | 77 | .05 | .01 | .05 | 3. | 1.01 | 18.25 | 221 | .02 | .02 | .00 | 451. |
| 1.01 | 6.30 | 78 | .05 | .01 | .05 | 4. | 1.01 | 18.30 | 222 | .02 | .02 | .00 | 405. |
| 1.01 | 6.35 | 79 | .05 | .01 | .04 | 5. | 1.01 | 18.35 | 223 | .02 | .02 | .00 | 355. |
| 1.01 | 6.40 | 80 | .05 | .01 | .04 | 7. | 1.01 | 18.40 | 224 | .02 | .02 | .00 | 306. |
| 1.01 | 6.45 | 81 | .05 | .01 | .04 | 8. | 1.01 | 18.45 | 225 | .02 | .02 | .00 | 261. |
| 1.01 | 6.50 | 82 | .05 | .01 | .04 | 10. | 1.01 | 18.50 | 226 | .02 | .02 | .00 | 220. |
| 1.01 | 6.55 | 83 | .05 | .01 | .04 | 12. | 1.01 | 18.55 | 227 | .02 | .02 | .00 | 185. |
| 1.01 | 7.00 | 84 | .05 | .01 | .04 | 14. | 1.01 | 19.00 | 228 | .02 | .02 | .00 | 169. |
| 1.01 | 7.05 | 85 | .05 | .01 | .04 | 16. | 1.01 | 19.05 | 229 | .02 | .02 | .00 | 154. |
| 1.01 | 7.10 | 86 | .05 | .01 | .04 | 18. | 1.01 | 19.10 | 230 | .02 | .02 | .00 | 141. |
| 1.01 | 7.15 | 87 | .05 | .01 | .04 | 20. | 1.01 | 19.15 | 231 | .02 | .02 | .00 | 128. |
| 1.01 | 7.20 | 88 | .05 | .02 | .04 | 23. | 1.01 | 19.20 | 232 | .02 | .02 | .00 | 117. |
| 1.01 | 7.25 | 89 | .05 | .02 | .04 | 25. | 1.01 | 19.25 | 233 | .02 | .02 | .00 | 107. |
| 1.01 | 7.30 | 90 | .05 | .02 | .04 | 27. | 1.01 | 19.30 | 234 | .02 | .02 | .00 | 98. |
| 1.01 | 7.35 | 91 | .05 | .02 | .04 | 29. | 1.01 | 19.35 | 235 | .02 | .02 | .00 | 89. |
| 1.01 | 7.40 | 92 | .05 | .02 | .03 | 32. | 1.01 | 19.40 | 236 | .02 | .02 | .00 | 81. |
| 1.01 | 7.45 | 93 | .05 | .02 | .03 | 34. | 1.01 | 19.45 | 237 | .02 | .02 | .00 | 74. |
| 1.01 | 7.50 | 94 | .05 | .02 | .03 | 36. | 1.01 | 19.50 | 238 | .02 | .02 | .00 | 68. |
| 1.01 | 7.55 | 95 | .05 | .02 | .03 | 38. | 1.01 | 19.55 | 239 | .02 | .02 | .00 | 62. |
| 1.01 | 8.00 | 96 | .05 | .02 | .03 | 40. | 1.01 | 20.00 | 240 | .02 | .02 | .00 | 56. |
| 1.01 | 8.05 | 97 | .05 | .02 | .03 | 42. | 1.01 | 20.05 | 241 | .02 | .02 | .00 | 53. |
| 1.01 | 8.10 | 98 | .05 | .02 | .03 | 44. | 1.01 | 20.10 | 242 | .02 | .02 | .00 | 51. |
| 1.01 | 8.15 | 99 | .05 | .02 | .03 | 46. | 1.01 | 20.15 | 243 | .02 | .02 | .00 | 50. |
| 1.01 | 8.20 | 100 | .05 | .02 | .03 | 47. | 1.01 | 20.20 | 244 | .02 | .02 | .00 | 49. |
| 1.01 | 8.25 | 101 | .05 | .02 | .03 | 49. | 1.01 | 20.25 | 245 | .02 | .02 | .00 | 49. |
| 1.01 | 8.30 | 102 | .05 | .02 | .03 | 51. | 1.01 | 20.30 | 246 | .02 | .02 | .00 | 48. |
| 1.01 | 8.35 | 103 | .05 | .02 | .03 | 52. | 1.01 | 20.35 | 247 | .02 | .02 | .00 | 48. |
| 1.01 | 8.40 | 104 | .05 | .03 | .03 | 54. | 1.01 | 20.40 | 248 | .02 | .02 | .00 | 47. |
| 1.01 | 8.45 | 105 | .05 | .03 | .03 | 56. | 1.01 | 20.45 | 249 | .02 | .02 | .00 | 47. |
| 1.01 | 8.50 | 106 | .05 | .03 | .03 | 57. | 1.01 | 20.50 | 250 | .02 | .02 | .00 | 47. |
| 1.01 | 8.55 | 107 | .05 | .03 | .03 | 59. | 1.01 | 20.55 | 251 | .02 | .02 | .00 | 47. |
| 1.01 | 9.00 | 108 | .05 | .03 | .03 | 60. | 1.01 | 21.00 | 252 | .02 | .02 | .00 | 46. |
| 1.01 | 9.05 | 109 | .05 | .03 | .03 | 62. | 1.01 | 21.05 | 253 | .02 | .02 | .00 | 46. |
| 1.01 | 9.10 | 110 | .05 | .03 | .03 | 63. | 1.01 | 21.10 | 254 | .02 | .02 | .00 | 46. |
| 1.01 | 9.15 | 111 | .05 | .03 | .02 | 64. | 1.01 | 21.15 | 255 | .02 | .02 | .00 | 46. |
| 1.01 | 9.20 | 112 | .05 | .03 | .02 | 66. | 1.01 | 21.20 | 256 | .02 | .02 | .00 | 46. |
| 1.01 | 9.25 | 113 | .05 | .03 | .02 | 67. | 1.01 | 21.25 | 257 | .02 | .02 | .00 | 46. |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.01 | 9.30 | 114 | .05 | .03 | .02 | 68. | 1.01 | 21.30 | 256 | .02 | .02 | .00 | 46. |
| 1.01 | 9.35 | 115 | .05 | .03 | .02 | 70. | 1.01 | 21.35 | 259 | .02 | .02 | .00 | 46. |
| 1.01 | 9.40 | 116 | .05 | .03 | .02 | 71. | 1.01 | 21.40 | 260 | .02 | .02 | .00 | 46. |
| 1.01 | 9.45 | 117 | .05 | .03 | .02 | 72. | 1.01 | 21.45 | 261 | .02 | .02 | .00 | 46. |
| 1.01 | 9.50 | 118 | .05 | .03 | .02 | 73. | 1.01 | 21.50 | 262 | .02 | .02 | .00 | 46. |
| 1.01 | 9.55 | 119 | .05 | .03 | .02 | 74. | 1.01 | 21.55 | 263 | .02 | .02 | .00 | 46. |
| 1.01 | 10.00 | 120 | .05 | .03 | .02 | 75. | 1.01 | 22.00 | 264 | .02 | .02 | .00 | 46. |
| 1.01 | 10.05 | 121 | .05 | .03 | .02 | 76. | 1.01 | 22.05 | 265 | .02 | .02 | .00 | 46. |
| 1.01 | 10.10 | 122 | .05 | .03 | .02 | 77. | 1.01 | 22.10 | 266 | .02 | .02 | .00 | 46. |
| 1.01 | 10.15 | 123 | .05 | .03 | .02 | 78. | 1.01 | 22.15 | 267 | .02 | .02 | .00 | 46. |
| 1.01 | 10.20 | 124 | .05 | .03 | .02 | 79. | 1.01 | 22.20 | 268 | .02 | .02 | .00 | 46. |
| 1.01 | 10.25 | 125 | .05 | .03 | .02 | 80. | 1.01 | 22.25 | 269 | .02 | .02 | .00 | 46. |
| 1.01 | 10.30 | 126 | .05 | .03 | .02 | 81. | 1.01 | 22.30 | 270 | .02 | .02 | .00 | 46. |
| 1.01 | 10.35 | 127 | .05 | .03 | .02 | 82. | 1.01 | 22.35 | 271 | .02 | .02 | .00 | 46. |
| 1.01 | 10.40 | 128 | .05 | .03 | .02 | 83. | 1.01 | 22.40 | 272 | .02 | .02 | .00 | 46. |
| 1.01 | 10.45 | 129 | .05 | .03 | .02 | 84. | 1.01 | 22.45 | 273 | .02 | .02 | .00 | 46. |
| 1.01 | 10.50 | 130 | .05 | .03 | .02 | 85. | 1.01 | 22.50 | 274 | .02 | .02 | .00 | 46. |
| 1.01 | 10.55 | 131 | .05 | .03 | .02 | 86. | 1.01 | 22.55 | 275 | .02 | .02 | .00 | 46. |
| 1.01 | 11.00 | 132 | .05 | .03 | .02 | 86. | 1.01 | 23.00 | 276 | .02 | .02 | .00 | 46. |
| 1.01 | 11.05 | 133 | .05 | .03 | .02 | 87. | 1.01 | 23.05 | 277 | .02 | .02 | .00 | 46. |
| 1.01 | 11.10 | 134 | .05 | .04 | .02 | 88. | 1.01 | 23.10 | 278 | .02 | .02 | .00 | 46. |
| 1.01 | 11.15 | 135 | .05 | .04 | .02 | 89. | 1.01 | 23.15 | 279 | .02 | .02 | .00 | 46. |
| 1.01 | 11.20 | 136 | .05 | .04 | .02 | 90. | 1.01 | 23.20 | 280 | .02 | .02 | .00 | 46. |
| 1.01 | 11.25 | 137 | .05 | .04 | .02 | 90. | 1.01 | 23.25 | 281 | .02 | .02 | .00 | 46. |
| 1.01 | 11.30 | 138 | .05 | .04 | .02 | 91. | 1.01 | 23.30 | 282 | .02 | .02 | .00 | 46. |
| 1.01 | 11.35 | 139 | .05 | .04 | .02 | 92. | 1.01 | 23.35 | 283 | .02 | .02 | .00 | 46. |
| 1.01 | 11.40 | 140 | .05 | .04 | .02 | 92. | 1.01 | 23.40 | 284 | .02 | .02 | .00 | 46. |
| 1.01 | 11.45 | 141 | .05 | .04 | .02 | 93. | 1.01 | 23.45 | 285 | .02 | .02 | .00 | 46. |
| 1.01 | 11.50 | 142 | .05 | .04 | .02 | 94. | 1.01 | 23.50 | 286 | .02 | .02 | .00 | 46. |
| 1.01 | 11.55 | 143 | .05 | .04 | .02 | 94. | 1.01 | 23.55 | 287 | .02 | .02 | .00 | 46. |
| 1.01 | 12.00 | 144 | .05 | .04 | .02 | 95. | 1.02 | 0.00 | 288 | .02 | .02 | .00 | 46. |

SUM 27.56 22.92 4.64 61351.
( 780.)( 582.)( 118.)( 1737.27)

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 1852. | 721. | 213. | 213. | 61339. |
| CMS | 52. | 20. | 6. | 6. | 1737. |
| INCHES | | 19.32 | 22.85 | 22.85 | 22.85 |
| MM | | 490.78 | 580.26 | 580.26 | 580.26 |
| AC-FT | | 357. | 422. | 422. | 422. |
| THOUS CU M | | 441. | 521. | 521. | 521. |

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTING THROUGH SPILLWAY

| | ISTAG | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|---|
| POND | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |

ROUTING DATA

| QLOSS | CLOSS | AVG | IRES | ISAME | IOPT | IPMP | LSTR |
|---|---|---|---|---|---|---|---|
| 0.0 | 0.000 | 0.00 | 1 | 1 | 0 | 0 | 0 |

| NSTPS | NSTOL | LAG | AMSKK | X | TSK | STORA | ISPRAT |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0.000 | 0.000 | 0.000 | -900. | -1 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| STAGE | 900.00 | 901.00 | 902.00 | 903.00 | 904.00 | 904.50 | 904.60 | 905.00 | 905.50 | 906.50 |
| FLOW | 0.00 | 15.00 | 54.00 | 115.00 | 208.00 | 270.00 | 350.00 | 980.00 | 2210.00 | 5720.00 |
| SURFACE AREA= | 5. | 7. | 9. | 10. | 11. | 12. | 14. | | | |
| CAPACITY= | 0. | 18. | 36. | 46. | 55. | 64. | 83. | | | |
| ELEVATION= | 897. | 900. | 902. | 903. | 904. | 905. | 906. | | | |

| CREL | SPWID | COOM | EXPW | ELEVL | COOL | CAREA | EXPL |
|---|---|---|---|---|---|---|---|
| 900.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

DAM DATA

| TOPEL | COOD | EXPD | DAMWID |
|---|---|---|---|
| 904.5 | 0.0 | 0.0 | 0. |

**********  **********  **********  **********  **********

SUB-AREA RUNOFF COMPUTATION

RUNOFF FROM LOWER WATERSHED

| ISTAO | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|
| INFLOW | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |

HYDROGRAPH DATA

| IHYDR | IUNG | TAREA | SNAP | TRSDA | TRSPC | RATIO | ISNOW | ISAME | LOCAL |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | .06 | 0.00 | .06 | 1.00 | 0.000 | 0 | 1 | 0 |

PRECIP DATA

| SPFE | PMS | R6 | R12 | R24 | R48 | R72 | R96 |
|---|---|---|---|---|---|---|---|
| 0.00 | 26.50 | 102.00 | 120.00 | 130.00 | 0.00 | 0.00 | 0.00 |

LOSS DATA

| LROPT | STRKR | DLTKR | RTIOL | ERAIN | STRKS | RTIOK | STRTL | CNSTL | ALSMX | RTIMP |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.00 | 0.00 | 1.00 | 0.00 | 0.06 | 1.00 | -1.00 | -100.00 | 0.00 | 0.00 |

CURVE NO = -100.00  METHSS = -1.00  EFFECT CN = 100.00

UNIT HYDROGRAPH DATA

TC= 0.00  LAG= .10

RECESSION DATA

STRTQ= -.01  QRCSN= -.01  RTIOR= 1.00

TIME INCREMENT TOO LARGE--(NMN IS GT LAG/2)

UNIT HYDROGRAPH 8 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .10 VOL= 1.00

130. 192. 85. 33. 13. 5. 2. 1.

| MO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | COMP Q | END-OF-PERIOD FLOW MO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | COMP Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.01 | .05 | 1 | .01 | .01 | .00 | 2. | 1.01 | 12.05 | 145 | .23 | .23 | .00 | 51. |
| 1.01 | .10 | 2 | .01 | .01 | .00 | 5. | 1.01 | 12.10 | 146 | .23 | .23 | .00 | 82. |
| 1.01 | .15 | 3 | .01 | .01 | .00 | 6. | 1.01 | 12.15 | 147 | .23 | .23 | .00 | 95. |
| 1.01 | .20 | 4 | .01 | .01 | -.00 | 6. | 1.01 | 12.20 | 148 | .23 | .23 | .00 | 100. |
| 1.01 | .25 | 5 | .01 | .01 | -.00 | 7. | 1.01 | 12.25 | 149 | .23 | .23 | -.00 | 102. |
| 1.01 | .30 | 6 | .01 | .01 | -.00 | 7. | 1.01 | 12.30 | 150 | .23 | .23 | .00 | 103. |
| 1.01 | .35 | 7 | .01 | .01 | -.00 | 7. | 1.01 | 12.35 | 151 | .23 | .23 | .00 | 103. |
| 1.01 | .40 | 8 | .01 | .01 | -.00 | 7. | 1.01 | 12.40 | 152 | .23 | .23 | -.00 | 104. |
| 1.01 | .45 | 9 | .01 | .01 | .00 | 7. | 1.01 | 12.45 | 153 | .23 | .23 | .00 | 104. |
| 1.01 | .50 | 10 | .01 | .01 | .00 | 7. | 1.01 | 12.50 | 154 | .23 | .23 | .00 | 104. |
| 1.01 | .55 | 11 | .01 | .01 | .00 | 7. | 1.01 | 12.55 | 155 | .23 | .23 | -.00 | 104. |
| 1.01 | 1.00 | 12 | .01 | .01 | .00 | 7. | 1.01 | 13.00 | 156 | .23 | .23 | -.00 | 104. |
| 1.01 | 1.05 | 13 | .01 | .01 | .00 | 7. | 1.01 | 13.05 | 157 | .27 | .27 | -.00 | 109. |
| 1.01 | 1.10 | 14 | .01 | .01 | -.00 | 7. | 1.01 | 13.10 | 158 | .27 | .27 | -.00 | 118. |
| 1.01 | 1.15 | 15 | .01 | .01 | .00 | 7. | 1.01 | 13.15 | 159 | .27 | .27 | -.00 | 122. |
| 1.01 | 1.20 | 16 | .01 | .01 | -.00 | 7. | 1.01 | 13.20 | 160 | .27 | .27 | -.00 | 123. |
| 1.01 | 1.25 | 17 | .01 | .01 | .00 | 7. | 1.01 | 13.25 | 161 | .27 | .27 | -.00 | 124. |
| 1.01 | 1.30 | 18 | .01 | .01 | .00 | 7. | 1.01 | 13.30 | 162 | .27 | .27 | -.00 | 124. |
| 1.01 | 1.35 | 19 | .01 | .01 | .00 | 7. | 1.01 | 13.35 | 163 | .27 | .27 | -.00 | 124. |
| 1.01 | 1.40 | 20 | .01 | .01 | .00 | 7. | 1.01 | 13.40 | 164 | .27 | .27 | -.00 | 124. |
| 1.01 | 1.45 | 21 | .01 | .01 | .00 | 7. | 1.01 | 13.45 | 165 | .27 | .27 | -.00 | 124. |
| 1.01 | 1.50 | 22 | .01 | .01 | .00 | 7. | 1.01 | 13.50 | 166 | .27 | .27 | -.00 | 124. |
| 1.01 | 1.55 | 23 | .01 | .01 | -.00 | 7. | 1.01 | 13.55 | 167 | .27 | .27 | -.00 | 124. |
| 1.01 | 2.00 | 24 | .01 | .01 | .00 | 7. | 1.01 | 14.00 | 168 | .27 | .27 | .00 | 124. |
| 1.01 | 2.05 | 25 | .01 | .01 | .00 | 7. | 1.01 | 14.05 | 169 | .34 | .34 | -.00 | 133. |
| 1.01 | 2.10 | 26 | .01 | .01 | .00 | 7. | 1.01 | 14.10 | 170 | .34 | .34 | .00 | 146. |
| 1.01 | 2.15 | 27 | .01 | .01 | -.00 | 7. | 1.01 | 14.15 | 171 | .34 | .34 | -.00 | 152. |
| 1.01 | 2.20 | 28 | .01 | .01 | .00 | 7. | 1.01 | 14.20 | 172 | .34 | .34 | .00 | 154. |
| 1.01 | 2.25 | 29 | .01 | .01 | .00 | 7. | 1.01 | 14.25 | 173 | .34 | .34 | -.00 | 155. |
| 1.01 | 2.30 | 30 | .01 | .01 | -.00 | 7. | 1.01 | 14.30 | 174 | .34 | .34 | .00 | 155. |
| 1.01 | 2.35 | 31 | .01 | .01 | .00 | 7. | 1.01 | 14.35 | 175 | .34 | .34 | .00 | 155. |
| 1.01 | 2.40 | 32 | .01 | .01 | .00 | 7. | 1.01 | 14.40 | 176 | .34 | .34 | .00 | 155. |
| 1.01 | 2.45 | 33 | .01 | .01 | -.00 | 7. | 1.01 | 14.45 | 177 | .34 | .34 | .00 | 155. |
| 1.01 | 2.50 | 34 | .01 | .01 | .00 | 7. | 1.01 | 14.50 | 178 | .34 | .34 | .00 | 155. |
| 1.01 | 2.55 | 35 | .01 | .01 | .00 | 7. | 1.01 | 14.55 | 179 | .34 | .34 | -.00 | 155. |
| 1.01 | 3.00 | 36 | .01 | .01 | .00 | 7. | 1.01 | 15.00 | 180 | .34 | .34 | .00 | 155. |
| 1.01 | 3.05 | 37 | .01 | .01 | .00 | 7. | 1.01 | 15.05 | 181 | .21 | .21 | .00 | 138. |
| 1.01 | 3.10 | 38 | .01 | .01 | .00 | 7. | 1.01 | 15.10 | 182 | .41 | .41 | .00 | 139. |
| 1.01 | 3.15 | 39 | .01 | .01 | .00 | 7. | 1.01 | 15.15 | 183 | .41 | .41 | .00 | 168. |
| 1.01 | 3.20 | 40 | .01 | .01 | .00 | 7. | 1.01 | 15.20 | 184 | .62 | .62 | .00 | 207. |
| 1.01 | 3.25 | 41 | .01 | .01 | .00 | 7. | 1.01 | 15.25 | 185 | .72 | .72 | -.00 | 265. |
| 1.01 | 3.30 | 42 | .01 | .01 | .00 | 7. | 1.01 | 15.30 | 186 | 1.75 | 1.75 | .00 | 458. |
| 1.01 | 3.35 | 43 | .01 | .01 | -.00 | 7. | 1.01 | 15.35 | 187 | 2.88 | 2.88 | -.00 | 799. |
| 1.01 | 3.40 | 44 | .01 | .01 | .00 | 7. | 1.01 | 15.40 | 188 | 1.13 | 1.13 | .00 | 882. |
| 1.01 | 3.45 | 45 | .01 | .01 | .00 | 7. | 1.01 | 15.45 | 189 | .72 | .72 | -.00 | 624. |
| 1.01 | 3.50 | 46 | .01 | .01 | .00 | 7. | 1.01 | 15.50 | 190 | .62 | .62 | -.00 | 435. |
| 1.01 | 3.55 | 47 | .01 | .01 | .00 | 7. | 1.01 | 15.55 | 191 | .41 | .41 | .00 | 316. |
| 1.01 | 4.00 | 48 | .01 | .01 | .00 | 7. | 1.01 | 16.00 | 192 | .41 | .41 | -.00 | 240. |
| 1.01 | 4.05 | 49 | .01 | .01 | .00 | 7. | 1.01 | 16.05 | 193 | .32 | .32 | .00 | 196. |
| 1.01 | 4.10 | 50 | .01 | .01 | -.00 | 7. | 1.01 | 16.10 | 194 | .32 | .32 | .00 | 165. |
| 1.01 | 4.15 | 51 | .01 | .01 | .00 | 7. | 1.01 | 16.15 | 195 | .32 | .32 | .00 | 152. |
| 1.01 | 4.20 | 52 | .01 | .01 | .00 | 7. | 1.01 | 16.20 | 196 | .32 | .32 | .00 | 147. |
| 1.01 | 4.25 | 53 | .01 | .01 | .00 | 7. | 1.01 | 16.25 | 197 | .32 | .32 | -.00 | 145. |
| 1.01 | 4.30 | 54 | .01 | .01 | -.00 | 7. | 1.01 | 16.30 | 198 | .32 | .32 | .00 | 145. |
| 1.01 | 4.35 | 55 | .01 | .01 | .00 | 7. | 1.01 | 16.35 | 199 | .32 | .32 | .00 | 145. |
| 1.01 | 4.40 | 56 | .01 | .01 | .00 | 7. | 1.01 | 16.40 | 200 | .32 | .32 | .00 | 145. |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.01 | 4.45 | 57 | .01 | .01 | .00 | 7. | 1.01 | 16.45 | 201 | .32 | .32 | -.00 | 145. |
| 1.01 | 4.50 | 58 | .01 | .01 | -.00 | 7. | 1.01 | 16.50 | 202 | .32 | .32 | .00 | 145. |
| 1.01 | 4.55 | 59 | .01 | .01 | .00 | 7. | 1.01 | 16.55 | 203 | .32 | .32 | -.00 | 145. |
| 1.01 | 5.00 | 60 | .01 | .01 | .00 | 7. | 1.01 | 17.00 | 204 | .32 | .32 | .00 | 145. |
| 1.01 | 5.05 | 61 | .01 | .01 | .00 | 7. | 1.01 | 17.05 | 205 | .25 | .25 | .00 | 136. |
| 1.01 | 5.10 | 62 | .01 | .01 | -.00 | 7. | 1.01 | 17.10 | 206 | .25 | .25 | -.00 | 123. |
| 1.01 | 5.15 | 63 | .01 | .01 | .00 | 7. | 1.01 | 17.15 | 207 | .25 | .25 | -.00 | 117. |
| 1.01 | 5.20 | 64 | .01 | .01 | .00 | 7. | 1.01 | 17.20 | 208 | .25 | .25 | .00 | 115. |
| 1.01 | 5.25 | 65 | .01 | .01 | -.00 | 7. | 1.01 | 17.25 | 209 | .25 | .25 | -.00 | 114. |
| 1.01 | 5.30 | 66 | .01 | .01 | .00 | 7. | 1.01 | 17.30 | 210 | .25 | .25 | .00 | 114. |
| 1.01 | 5.35 | 67 | .01 | .01 | .00 | 7. | 1.01 | 17.35 | 211 | .25 | .25 | -.00 | 114. |
| 1.01 | 5.40 | 68 | .01 | .01 | .00 | 7. | 1.01 | 17.40 | 212 | .25 | .25 | -.00 | 114. |
| 1.01 | 5.45 | 69 | .01 | .01 | -.00 | 7. | 1.01 | 17.45 | 213 | .25 | .25 | .00 | 114. |
| 1.01 | 5.50 | 70 | .01 | .01 | -.00 | 7. | 1.01 | 17.50 | 214 | .25 | .25 | -.00 | 114. |
| 1.01 | 5.55 | 71 | .01 | .01 | -.00 | 7. | 1.01 | 17.55 | 215 | .25 | .25 | -.00 | 114. |
| 1.01 | 6.00 | 72 | .01 | .01 | -.00 | 7. | 1.01 | 18.00 | 216 | .25 | .25 | -.00 | 114. |
| 1.01 | 6.05 | 73 | .07 | .07 | .00 | 13. | 1.01 | 18.05 | 217 | .02 | .02 | .00 | 85. |
| 1.01 | 6.10 | 74 | .07 | .07 | .00 | 23. | 1.01 | 18.10 | 218 | .02 | .02 | .00 | 41. |
| 1.01 | 6.15 | 75 | .07 | .07 | .00 | 28. | 1.01 | 18.15 | 219 | .02 | .02 | .00 | 22. |
| 1.01 | 6.20 | 76 | .07 | .07 | .00 | 29. | 1.01 | 18.20 | 220 | .02 | .02 | .00 | 15. |
| 1.01 | 6.25 | 77 | .07 | .07 | .00 | 30. | 1.01 | 18.25 | 221 | .02 | .02 | .00 | 12. |
| 1.01 | 6.30 | 78 | .07 | .07 | .00 | 30. | 1.01 | 18.30 | 222 | .02 | .02 | .00 | 11. |
| 1.01 | 6.35 | 79 | .07 | .07 | .00 | 30. | 1.01 | 18.35 | 223 | .02 | .02 | .00 | 10. |
| 1.01 | 6.40 | 80 | .07 | .07 | .00 | 30. | 1.01 | 18.40 | 224 | .02 | .02 | .00 | 10. |
| 1.01 | 6.45 | 81 | .07 | .07 | -.00 | 30. | 1.01 | 18.45 | 225 | .02 | .02 | .00 | 10. |
| 1.01 | 6.50 | 82 | .07 | .07 | .00 | 30. | 1.01 | 18.50 | 226 | .02 | .02 | .00 | 10. |
| 1.01 | 6.55 | 83 | .07 | .07 | .00 | 30. | 1.01 | 18.55 | 227 | .02 | .02 | -.00 | 10. |
| 1.01 | 7.00 | 84 | .07 | .07 | .00 | 30. | 1.01 | 19.00 | 228 | .02 | .02 | .00 | 10. |
| 1.01 | 7.05 | 85 | .07 | .07 | -.00 | 30. | 1.01 | 19.05 | 229 | .02 | .02 | .00 | 10. |
| 1.01 | 7.10 | 86 | .07 | .07 | .00 | 30. | 1.01 | 19.10 | 230 | .02 | .02 | .00 | 10. |
| 1.01 | 7.15 | 87 | .07 | .07 | .00 | 30. | 1.01 | 19.15 | 231 | .02 | .02 | .00 | 10. |
| 1.01 | 7.20 | 88 | .07 | .07 | .00 | 30. | 1.01 | 19.20 | 232 | .02 | .02 | .00 | 10. |
| 1.01 | 7.25 | 89 | .07 | .07 | .00 | 30. | 1.01 | 19.25 | 233 | .02 | .02 | .00 | 10. |
| 1.01 | 7.30 | 90 | .07 | .07 | .00 | 30. | 1.01 | 19.30 | 234 | .02 | .02 | -.00 | 10. |
| 1.01 | 7.35 | 91 | .07 | .07 | .00 | 30. | 1.01 | 19.35 | 235 | .02 | .02 | .00 | 10. |
| 1.01 | 7.40 | 92 | .07 | .07 | .00 | 30. | 1.01 | 19.40 | 236 | .02 | .02 | .00 | 10. |
| 1.01 | 7.45 | 93 | .07 | .07 | .00 | 30. | 1.01 | 19.45 | 237 | .02 | .02 | -.00 | 10. |
| 1.01 | 7.50 | 94 | .07 | .07 | .00 | 30. | 1.01 | 19.50 | 238 | .02 | .02 | .00 | 10. |
| 1.01 | 7.55 | 95 | .07 | .07 | .00 | 30. | 1.01 | 19.55 | 239 | .02 | .02 | .00 | 10. |
| 1.01 | 8.00 | 96 | .07 | .07 | .00 | 30. | 1.01 | 20.00 | 240 | .02 | .02 | .00 | 10. |
| 1.01 | 8.05 | 97 | .07 | .07 | .00 | 30. | 1.01 | 20.05 | 241 | .02 | .02 | .00 | 10. |
| 1.01 | 8.10 | 98 | .07 | .07 | -.00 | 30. | 1.01 | 20.10 | 242 | .02 | .02 | .00 | 10. |
| 1.01 | 8.15 | 99 | .07 | .07 | .00 | 30. | 1.01 | 20.15 | 243 | .02 | .02 | .00 | 10. |
| 1.01 | 8.20 | 100 | .07 | .07 | .00 | 30. | 1.01 | 20.20 | 244 | .02 | .02 | .00 | 10. |
| 1.01 | 8.25 | 101 | .07 | .07 | -.00 | 30. | 1.01 | 20.25 | 245 | .02 | .02 | .00 | 10. |
| 1.01 | 8.30 | 102 | .07 | .07 | .00 | 30. | 1.01 | 20.30 | 246 | .02 | .02 | .00 | 10. |
| 1.01 | 8.35 | 103 | .07 | .07 | .00 | 30. | 1.01 | 20.35 | 247 | .02 | .02 | .00 | 10. |
| 1.01 | 8.40 | 104 | .07 | .07 | -.00 | 30. | 1.01 | 20.40 | 248 | .02 | .02 | .00 | 10. |
| 1.01 | 8.45 | 105 | .07 | .07 | .00 | 30. | 1.01 | 20.45 | 249 | .02 | .02 | .00 | 10. |
| 1.01 | 8.50 | 106 | .07 | .07 | -.00 | 30. | 1.01 | 20.50 | 250 | .02 | .02 | .00 | 10. |
| 1.01 | 8.55 | 107 | .07 | .07 | .00 | 30. | 1.01 | 20.55 | 251 | .02 | .02 | .00 | 10. |
| 1.01 | 9.00 | 108 | .07 | .07 | .00 | 30. | 1.01 | 21.00 | 252 | .02 | .02 | .00 | 10. |
| 1.01 | 9.05 | 109 | .07 | .07 | .00 | 30. | 1.01 | 21.05 | 253 | .02 | .02 | .00 | 10. |
| 1.01 | 9.10 | 110 | .07 | .07 | .00 | 30. | 1.01 | 21.10 | 254 | .02 | .02 | .00 | 10. |
| 1.01 | 9.15 | 111 | .07 | .07 | .00 | 30. | 1.01 | 21.15 | 255 | .02 | .02 | .00 | 10. |
| 1.01 | 9.20 | 112 | .07 | .07 | -.00 | 30. | 1.01 | 21.20 | 256 | .02 | .02 | .00 | 10. |
| 1.01 | 9.25 | 113 | .07 | .07 | .00 | 30. | 1.01 | 21.25 | 257 | .02 | .02 | -.00 | 10. |
| 1.01 | 9.30 | 114 | .07 | .07 | -.00 | 30. | 1.01 | 21.30 | 258 | .02 | .02 | .00 | 10. |
| 1.01 | 9.35 | 115 | .07 | .07 | .00 | 30. | 1.01 | 21.35 | 259 | .02 | .02 | -.00 | 10. |
| 1.01 | 9.40 | 116 | .07 | .07 | .00 | 30. | 1.01 | 21.40 | 260 | .02 | .02 | .00 | 10. |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.01 | 9.45 | 117 | .07 | .07 | .00 | 30. | 1.01 | 21.45 | 261 | .02 | .02 | .00 | 10. |
| 1.01 | 9.50 | 118 | .07 | .07 | .00 | 30. | 1.01 | 21.50 | 262 | .02 | .02 | -.00 | 10. |
| 1.01 | 9.55 | 119 | .07 | .07 | .00 | 30. | 1.01 | 21.55 | 263 | .02 | .02 | .00 | 10. |
| 1.01 | 10.00 | 120 | .07 | .07 | .00 | 30. | 1.01 | 22.00 | 264 | .02 | .02 | .00 | 10. |
| 1.01 | 10.05 | 121 | .07 | .07 | -.00 | 30. | 1.01 | 22.05 | 265 | .02 | .02 | .00 | 10. |
| 1.01 | 10.10 | 122 | .07 | .07 | .00 | 30. | 1.01 | 22.10 | 266 | .02 | .02 | .00 | 10. |
| 1.01 | 10.15 | 123 | .07 | .07 | -.00 | 30. | 1.01 | 22.15 | 267 | .02 | .02 | .00 | 10. |
| 1.01 | 10.20 | 124 | .07 | .07 | .00 | 30. | 1.01 | 22.20 | 268 | .02 | .02 | .00 | 10. |
| 1.01 | 10.25 | 125 | .07 | .07 | .00 | 30. | 1.01 | 22.25 | 269 | .02 | .02 | .00 | 10. |
| 1.01 | 10.30 | 126 | .07 | .07 | .00 | 30. | 1.01 | 22.30 | 270 | .02 | .02 | -.00 | 10. |
| 1.01 | 10.35 | 127 | .07 | .07 | -.00 | 30. | 1.01 | 22.35 | 271 | .02 | .02 | .00 | 10. |
| 1.01 | 10.40 | 128 | .07 | .07 | .00 | 30. | 1.01 | 22.40 | 272 | .02 | .02 | .00 | 10. |
| 1.01 | 10.45 | 129 | .07 | .07 | .00 | 30. | 1.01 | 22.45 | 273 | .02 | .02 | .00 | 10. |
| 1.01 | 10.50 | 130 | .07 | .07 | .00 | 30. | 1.01 | 22.50 | 274 | .02 | .02 | .00 | 10. |
| 1.01 | 10.55 | 131 | .07 | .07 | .00 | 30. | 1.01 | 22.55 | 275 | .02 | .02 | .00 | 10. |
| 1.01 | 11.00 | 132 | .07 | .07 | .00 | 30. | 1.01 | 23.00 | 276 | .02 | .02 | -.00 | 10. |
| 1.01 | 11.05 | 133 | .07 | .07 | .00 | 30. | 1.01 | 23.05 | 277 | .02 | .02 | .00 | 10. |
| 1.01 | 11.10 | 134 | .07 | .07 | .00 | 30. | 1.01 | 23.10 | 278 | .02 | .02 | .00 | 10. |
| 1.01 | 11.15 | 135 | .07 | .07 | .00 | 30. | 1.01 | 23.15 | 279 | .02 | .02 | .00 | 10. |
| 1.01 | 11.20 | 136 | .07 | .07 | .00 | 30. | 1.01 | 23.20 | 280 | .02 | .02 | .00 | 10. |
| 1.01 | 11.25 | 137 | .07 | .07 | .00 | 30. | 1.01 | 23.25 | 281 | .02 | .02 | .00 | 10. |
| 1.01 | 11.30 | 138 | .07 | .07 | .00 | 30. | 1.01 | 23.30 | 282 | .02 | .02 | .00 | 10. |
| 1.01 | 11.35 | 139 | .07 | .07 | .00 | 30. | 1.01 | 23.35 | 283 | .02 | .02 | .00 | 10. |
| 1.01 | 11.40 | 140 | .07 | .07 | -.00 | 30. | 1.01 | 23.40 | 284 | .02 | .02 | .00 | 10. |
| 1.01 | 11.45 | 141 | .07 | .07 | .00 | 30. | 1.01 | 23.45 | 285 | .02 | .02 | .00 | 10. |
| 1.01 | 11.50 | 142 | .07 | .07 | .00 | 30. | 1.01 | 23.50 | 286 | .02 | .02 | .00 | 10. |
| 1.01 | 11.55 | 143 | .07 | .07 | .00 | 30. | 1.01 | 23.55 | 287 | .02 | .02 | .00 | 10. |
| 1.01 | 12.00 | 144 | .07 | .07 | .00 | 30. | 1.02 | 0.00 | 288 | .02 | .02 | .00 | 10. |
| | | | | | | | | | SUM | 34.45 | 34.45 | .00 | 15794. |
| | | | | | | | | | | ( 875.)( | 875.)( | 0.)( | 447.24) |

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 892. | 171. | 55. | 55. | 15821. |
| CMS | 25. | 5. | 2. | 2. | 448. |
| INCHES | | 28.85 | 34.41 | 34.41 | 34.41 |
| MM | | 681.97 | 874.03 | 874.03 | 874.03 |
| AC-FT | | 85. | 109. | 109. | 109. |
| THOUS CU M | | 105. | 134. | 134. | 134. |

COMBINE HYDROGRAPHS

COMBINATION OF OUTFLOW FROM UPPER DIKE AND RUNOFF FROM LOWER WATERSHED

| | ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|---|
| | UP+LOW | 2 | 0 | 6 | 0 | 1 | 1 | 0 | 0 |

SUM OF 2 HYDROGRAPHS AT [illegible] PLAN 1 RTIO 6

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2. | 5. | 6. | 7. | 7. | 7. | 7. | 7. | 7. | 7. |
| 7. | 7. | 7. | 7. | 7. | 7. | 7. | 7. | 7. | 7. |
| 7. | 7. | 8. | 8. | 8. | 8. | 8. | 8. | 8. | 8. |
| 8. | 8. | 8. | 8. | 8. | 8. | 8. | 8. | 8. | 8. |
| 8. | 8. | 8. | 8. | 8. | 8. | 8. | 8. | 8. | 8. |
| 8. | 8. | 8. | 8. | 8. | 8. | 8. | 8. | 8. | 8. |
| 8. | 8. | 15. | 25. | 29. | 31. | 32. | 32. | 32. | 32. |
| 32. | 32. | 32. | 33. | 33. | 33. | 33. | 33. | 34. | 34. |
| 34. | 35. | 35. | 36. | 36. | 37. | 37. | 37. | 38. | 39. |
| 39. | 40. | 40. | 41. | 41. | 42. | 43. | 43. | 44. | 45. |
| 45. | 47. | 48. | 50. | 51. | 53. | 55. | 56. | 58. | 59. |
| 61. | 62. | 64. | 65. | 67. | 68. | 70. | 71. | 72. | 74. |
| 75. | 76. | 77. | 79. | 80. | 81. | 82. | 84. | 85. | 87. |
| 88. | 90. | 92. | 93. | 115. | 148. | 163. | 170. | 175. | 180. |
| 184. | 190. | 196. | 204. | 211. | 220. | 238. | 259. | 275. | 289. |
| 301. | 310. | 320. | 330. | 355. | 371. | 385. | 422. | 504. | 593. |
| 617. | 637. | 655. | 666. | 688. | 700. | 717. | 732. | 746. | 759. |
| 752. | 761. | 795. | 841. | 967. | 1099. | 1505. | 1678. | 1557. | 1596. |
| 1721. | 1852. | 1953. | 1991. | 1979. | 1916. | 1808. | 1670. | 1523. | 1390. |
| 1264. | 1156. | 1059. | 1071. | 1019. | 962. | 920. | 885. | 854. | 825. |
| 796. | 770. | 750. | 729. | 711. | 696. | 656. | 598. | 565. | 538. |
| 514. | 496. | 477. | 509. | 536. | 505. | 276. | 271. | 264. | 256. |
| 248. | 239. | 230. | 222. | 214. | 207. | 201. | 195. | 186. | 179. |
| 172. | 165. | 159. | 153. | 147. | 141. | 136. | 131. | 127. | 123. |
| 12. | 114. | 115. | 112. | 110. | 108. | 105. | 103. | 101. | 99. |
| 97. | 96. | 94. | 92. | 91. | 89. | 88. | 86. | 85. | 84. |
| 82. | 81. | 80. | 79. | 78. | 77. | 76. | 75. | 74. | 73. |
| 73. | 72. | 71. | 71. | 70. | 69. | 69. | 68. | | |

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 1991. | 848. | 260. | 260. | 74523. |
| CMS | 56. | 24. | 7. | 7. | 2111. |
| INCHES | | 14.42 | 23.79 | 23.79 | 23.79 |
| MM | | 493.15 | 604.34 | 604.34 | 604.34 |
| AC-FT | | 420. | 515. | 515. | 515. |
| THOUS CU M | | 519. | 636. | 636. | 636. |

**********  **********  **********  **********  **********

HYDROGRAPH ROUTING

ROUTING THROUGH LAKE, CLOSED SYSTEM

| ISTAO | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|
| POND 2 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |

ROUTING DATA

| QLOSS | CLOSS | AVG | IRES | ISAME | IOPT | IPMP | LSTR |
|---|---|---|---|---|---|---|---|
| 0.0 | 0.000 | 0.00 | 1 | 1 | 0 | 0 | 0 |

| NSTPS | NSTOL | LAG | AMSKK | X | TSK | STORA | ISPRAT |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0.000 | 0.000 | 0.000 | -897. | -1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| STAGE | 897.00 | 898.00 | 898.50 | 899.00 | 899.50 | 900.00 |
| FLOW | 0.00 | 25.00 | 165.00 | 825.00 | 825.00 | 1350.00 |
| SURFACE AREA= | 0. | 5. | 10. | 14. | 14. | 22. |
| CAPACITY= | 0. | 2. | 14. | 28. | 42. | 52. |
| ELEVATION= | 895. | 895. | 897. | 898. | 899. | 900. |

| CREL | SPWID | COQW | EXPW | ELEVL | COQL | CAREA | EXPL |
|---|---|---|---|---|---|---|---|
| 897.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

DAM DATA

| TOPEL | COQD | EXPD | DAMWID |
|---|---|---|---|
| 897.7 | 0.0 | 0.0 | 0. |

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

| OPERATION | STATION | AREA | PLAN | RATIOS APPLIED TO FLOWS | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | RATIO 1 .02 | RATIO 2 .03 | RATIO 3 .25 | RATIO 4 .30 | RATIO 5 .50 | RATIO 6 1.00 |
| HYDROGRAPH AT | INFLOW | .35 | 1 | 37. | 56. | 463. | 556. | 926. | 1852. |
| | | ( .91) | | ( 1.05)( | 1.57)( | 13.11)( | 15.75)( | 26.22)( | 52.45)( |
| ROUTED TO | POND 1 | .35 | 1 | 10. | 15. | 259. | 445. | 905. | 1827. |
| | | ( .91) | | ( .28)( | .42)( | 7.33)( | 12.61)( | 25.63)( | 51.75)( |
| HYDROGRAPH AT | INFLOW | .10 | 1 | 14. | 20. | 221. | 265. | 441. | 882. |
| | | ( .25) | | ( .40)( | .57)( | 6.25)( | 7.49)( | 12.49)( | 24.98)( |
| 2 COMBINED | | .45 | 1 | 22. | 33. | 327. | 449. | 881. | 1691. |
| | | ( 1.16) | | ( .63)( | .95)( | 9.26)( | 13.65)( | 27.79)( | 56.39)( |
| ROUTED TO | POND 2 | .45 | 1 | 0. | 8. | 281. | 391. | 890. | 1843. |
| | | ( 1.16) | | ( 0.00)( | .23)( | 7.95)( | 11.08)( | 25.21)( | 52.20)( |

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

| | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 900.00 | 900.00 | 904.50 |
| STORAGE | 18. | 18. | 59. |
| OUTFLOW | 0. | 0. | 270. |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| .02 | 900.67 | 0.00 | 23. | 10. | 0.00 | 18.33 | 0.00 |
| .13 | 900.99 | 0.00 | 25. | 15. | 0.00 | 18.33 | 0.00 |
| .25 | 901.41 | 0.00 | 28. | 259. | 0.00 | 16.75 | 0.00 |
| .50 | 902.86 | .16 | 50. | 485 | .83 | 16.50 | 0.00 |
| .75 | 904.95 | .45 | 64. | 905. | 2.58 | 16.25 | 0.00 |
| 1.00 | 905.34 | .84 | 69. | 1827. | 4.92 | 16.25 | 0.00 |



SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

| | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 896.90 | 897.70 | 897.70 |
| STORAGE | 13. | 22. | 22. |
| OUTFLOW | 0. | 0. | 0. |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| .02 | 897.63 | 0.00 | 21. | 0. | 0.00 | 0.00 | 0.00 |
| .13 | 897.83 | .10 | 23. | 5. | 4.00 | 23.58 | 0.00 |
| .25 | 898.72 | 1.02 | 37. | 281. | 11.17 | 17.17 | 0.00 |
| .50 | 898.94 | 1.24 | 41. | 591. | 11.58 | 16.75 | 0.00 |
| .75 | 899.56 | 1.86 | 53. | 890. | 13.50 | 16.42 | 0.00 |
| 1.00 | 900.47 | 2.77 | 73. | 1843. | 15.92 | 16.42 | 0.00 |

```
A1          BLACK DAM, ID. NO. 31154
A2          HEC-1  PHASE I DAM SAFETY INVESTIGATION
A3          100-YEAR FLOOD
B     144                   10
B1      3
K       0  INFLOW                                          1         1
K1    RUNOFF TO UPPER DIKE, 100-YR FLOOD BASED ON SULLIVAN PRECIP. 10-MIN. INCR.
M       0         2  0.3469
O     144
O1   .014     .014     .014     .014     .014     .014     .014     .014     .014     .014
O1   .014     .014     .014     .014     .014     .014     .014     .014     .014     .014
O1   .014     .014     .014     .014     .014     .014     .014     .014     .014     .014
O1   .014     .014     .014     .014     .014     .014     .028     .028     .028     .028
O1   .028     .028     .028     .028     .028     .028     .028     .028     .028     .028
O1   .028     .028     .028     .028     .044     .044     .044     .044     .044     .044
O1   .044     .044     .044     .062     .062     .062     .122     .122     .122     .264
O1   .384     .801    1.205     .384     .264     .122     .122     .122     .062     .062
O1   .062     .044     .044     .044     .044     .044     .044     .044     .044     .044
O1   .028     .028     .028     .028     .028     .028     .028     .028     .028     .028
O1   .028     .028     .028     .028     .028     .028     .028     .028     .014     .014
O1   .014     .014     .014     .014     .014     .014     .014     .014     .014     .014
O1   .014     .014     .014     .014     .014     .014     .014     .014     .014     .014
O1   .014     .014     .014     .014     .014     .014     .014     .014     .014     .014
O1   .014     .014     .014     .014
T                                                          -1       -49                .06
W2              .98
X      -10      -.1      2.5
K       1  POND 1                                          1         1
K1    ROUTING THROUGH SPILLWAY
Y                                    1
Y1      1                                                 -900       -1
Y4  900.0    901.0    902.0    903.0    904.0    904.5    904.6    905.0    905.5    906.5
Y5      0       15       54      115      208      270      350      980     2210     5720
SA      5        7        9       10       11       12       14
SE    897      900    902.3    903.3    904.2      905    906.4
SS    900
SD  904.5
```

```
K       0  INFLOW                                          1        1
K1   RUNOFF TO LOWER DAM, 100-YR FLOOD BASED ON SULLIVAN PRECIP. 10-MIN. INCR.
M       0        2   .0594
O   -144
I                                                                -1     -100
W2            0.1
X   -.01    -.01        1
K       2  UP+LOW
K1   COMBINATION OF OUTFLOW FROM UPPER DIKE AND RUNOFF FROM LOWER WATERSHED
K       1  POND 2                                          1        1
K1   ROUTING THROUGH LAKE, CLOSED SYSTEM
Y                                  1
Y1      1                                                -896.9       -1
Y4 897.7   898.0   898.5   899.0   899.5   900.0
Y5      0      25     165     425     825    1350
$A      0       3      10      14      18      22
$E    893     895     897     898     899     900
$$ 897.7
$D 897.7
K      99
A
A
A
```

**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
**********

RUN DATE= 79/08/09.
TIME= 11.30.49.

BLACK DAM, ID. NO. 31154
HEC-1 PHASE 1 DAM SAFETY INVESTIGATION
100-YEAR FLOOD

JOB SPECIFICATION

| NO | NHR | NMIN | IDAY | IHR | IMIN | METRC | IPLT | IPRT | NSTAN |
|---|---|---|---|---|---|---|---|---|---|
| 144 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | JOPER | NMI | LROPT | TRACE | | | |
| | | | 3 | 0 | 0 | 0 | | | |

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

RUNOFF TO UPPER DIKE, 100-YR FLOOD BASED ON SULLIVAN PRECIP, 10-MIN. INCR.

| | ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|---|
| | INFLOW | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |

HYDROGRAPH DATA

| IHYDG | IUHG | TAREA | SNAP | TRSDA | TRSPC | RATIO | ISNOW | ISAME | LOCAL |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 2 | .35 | 0.00 | .35 | 0.00 | 0.000 | 0 | 0 | 0 |

PRECIP DATA

| NP | STORM | DAJ | DAK |
|---|---|---|---|
| 144 | 0.00 | 0.00 | 0.00 |

PRECIP PATTERN

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 |
| .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 |
| .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 |
| .01 | .01 | .01 | .01 | .01 | .01 | .03 | .03 | .03 | .03 |
| .03 | .03 | .03 | .03 | .03 | .03 | .03 | .03 | .03 | .03 |
| .03 | .03 | .03 | .03 | .04 | .04 | .04 | .04 | .04 | .04 |
| .04 | .04 | .04 | .06 | .06 | .06 | .12 | .12 | .12 | .26 |
| .38 | .80 | 1.21 | .38 | .26 | .12 | .12 | .12 | .06 | .06 |
| .06 | .04 | .04 | .04 | .04 | .04 | .04 | .04 | .04 | .04 |
| .03 | .03 | .03 | .03 | .03 | .03 | .03 | .03 | .03 | .03 |
| .03 | .03 | .03 | .03 | .03 | .03 | .03 | .03 | .01 | .01 |
| .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 |
| .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 |
| .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 |
| .01 | .01 | .01 | .01 | | | | | | |

LOSS DATA

| LROPT | STRKR | DLTKR | RTIOL | ERAIN | STRKS | RTIOK | STRTL | CNSTL | ALSMX | RTIMP |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | 1.00 | -1.00 | -99.00 | 0.00 | .06 |

CURVE NO = -49.00 WETNESS = -1.00 EFFECT CN = 49.00

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= .98

RECESSION DATA
STRTQ= -10.00 QRCSN= -.10 RTIOR= 2.50

UNIT HYDROGRAPH 31 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .98 VOL= 1.00

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 11. | 32. | 67. | 111. | 144. | 157. | 156. | 141. | 121. | 94. |
| 70. | 54. | 42. | 35. | 25. | 20. | 15. | 12. | 9. | 7. |
| 6. | 4. | 3. | 3. | 2. | 2. | 1. | 1. | 1. | 0. |
| 0. | | | | | | | | | |

| 0 | | | | | | END-OF-PERIOD FLOW | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | COMP Q | MO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | COMP Q |
| 1.01 | .10 | 1 | .01 | .00 | .01 | 3. | 1.01 | 12.10 | 73 | 1.21 | .40 | .81 | 20. |
| 1.01 | .20 | 2 | .01 | .00 | .01 | 3. | 1.01 | 12.20 | 74 | .38 | .16 | .23 | 38. |
| 1.01 | .30 | 3 | .01 | .00 | .01 | 3. | 1.01 | 12.30 | 75 | .26 | .12 | .15 | 65. |
| 1.01 | .40 | 4 | .01 | .00 | .01 | 3. | 1.01 | 12.40 | 76 | .12 | .06 | .07 | 96. |
| 1.01 | .50 | 5 | .01 | .00 | .01 | 3. | 1.01 | 12.50 | 77 | .12 | .06 | .07 | 123. |
| 1.01 | 1.00 | 6 | .01 | .00 | .01 | 2. | 1.01 | 13.00 | 78 | .12 | .06 | .06 | 140. |
| 1.01 | 1.10 | 7 | .01 | .00 | .01 | 2. | 1.01 | 13.10 | 79 | .06 | .03 | .03 | 147. |
| 1.01 | 1.20 | 8 | .01 | .00 | .01 | 2. | 1.01 | 13.20 | 80 | .06 | .03 | .03 | 144. |
| 1.01 | 1.30 | 9 | .01 | .00 | .01 | 2. | 1.01 | 13.30 | 81 | .06 | .03 | .03 | 135. |
| 1.01 | 1.40 | 10 | .01 | .00 | .01 | 2. | 1.01 | 13.40 | 82 | .04 | .02 | .02 | 120. |
| 1.01 | 1.50 | 11 | .01 | .00 | .01 | 2. | 1.01 | 13.50 | 83 | .04 | .02 | .02 | 105. |
| 1.01 | 2.00 | 12 | .01 | .00 | .01 | 2. | 1.01 | 14.00 | 84 | .04 | .02 | .02 | 91. |
| 1.01 | 2.10 | 13 | .01 | .00 | .01 | 2. | 1.01 | 14.10 | 85 | .04 | .02 | .02 | 79. |
| 1.01 | 2.20 | | .01 | .00 | .01 | 2. | 1.01 | 14.20 | 86 | .04 | .02 | .02 | 69. |
| 1.01 | 2.30 | 15 | .01 | .00 | .01 | 2. | 1.01 | 14.30 | 87 | .04 | .02 | .02 | 61. |
| 1.01 | 2.40 | 16 | .01 | .00 | .01 | 2. | 1.01 | 14.40 | 88 | .04 | .02 | .02 | 54. |
| 1.01 | 2.50 | 17 | .01 | .00 | .01 | 2. | 1.01 | 14.50 | 89 | .04 | .02 | .02 | 49. |
| 1.01 | 3.00 | 18 | .01 | .00 | .01 | 2. | 1.01 | 15.00 | 90 | .04 | .02 | .02 | 44. |
| 1.01 | 3.10 | 19 | .01 | .00 | .01 | 2. | 1.01 | 15.10 | 91 | .03 | .01 | .01 | 41. |
| 1.01 | 3.20 | 20 | .01 | .00 | .01 | 2. | 1.01 | 15.20 | 92 | .03 | .01 | .01 | 38. |
| 1.01 | 3.30 | 21 | .01 | .00 | .01 | 2. | 1.01 | 15.30 | 93 | .03 | .01 | .01 | 36. |
| 1.01 | 3.40 | 22 | .01 | .00 | .01 | 2. | 1.01 | 15.40 | 94 | .03 | .01 | .01 | 34. |
| 1.01 | 3.50 | 23 | .01 | .00 | .01 | 2. | 1.01 | 15.50 | 95 | .03 | .01 | .01 | 31. |
| 1.01 | 4.00 | 24 | .01 | .00 | .01 | 2. | 1.01 | 16.00 | 96 | .03 | .01 | .01 | 29. |
| 1.01 | 4.10 | 25 | .01 | .00 | .01 | 1. | 1.01 | 16.10 | 97 | .03 | .01 | .01 | 27. |
| 1.01 | 4.20 | 26 | .01 | .00 | .01 | 1. | 1.01 | 16.20 | 98 | .03 | .01 | .01 | 26. |
| 1.01 | 4.30 | 27 | .01 | .00 | .01 | 1. | 1.01 | 16.30 | 99 | .03 | .01 | .01 | 24. |
| 1.01 | 4.40 | 28 | .01 | .00 | .01 | 1. | 1.01 | 16.40 | 100 | .03 | .01 | .01 | 23. |
| 1.01 | 4.50 | 29 | .01 | .00 | .01 | 1. | 1.01 | 16.50 | 101 | .03 | .02 | .01 | 23. |
| 1.01 | 5.00 | 30 | .01 | .00 | .01 | 1. | 1.01 | 17.00 | 102 | .03 | .02 | .01 | 22. |
| 1.01 | 5.10 | 31 | .01 | .00 | .01 | 1. | 1.01 | 17.10 | 103 | .03 | .02 | .01 | 21. |
| 1.01 | 5.20 | 32 | .01 | .00 | .01 | 1. | 1.01 | 17.20 | 104 | .03 | .02 | .01 | 21. |
| 1.01 | 5.30 | 33 | .01 | .00 | .01 | 1. | 1.01 | 17.30 | 105 | .03 | .02 | .01 | 21. |
| 1.01 | 5.40 | 34 | .01 | .00 | .01 | 1. | 1.01 | 17.40 | 106 | .03 | .02 | .01 | 21. |
| 1.01 | 5.50 | 35 | .01 | .00 | .01 | 1. | 1.01 | 17.50 | 107 | .03 | .02 | .01 | 21. |
| 1.01 | 6.00 | 36 | .01 | .00 | .01 | 1. | 1.01 | 18.00 | 108 | .03 | .02 | .01 | 20. |
| 1.01 | 6.10 | 37 | .03 | .00 | .03 | 1. | 1.01 | 18.10 | 109 | .01 | .01 | .01 | 20. |
| 1.01 | 6.20 | 38 | .03 | .00 | .03 | 1. | 1.01 | 18.20 | 110 | .01 | .01 | .01 | 20. |
| 1.01 | 6.30 | 39 | .03 | .00 | .03 | 1. | 1.01 | 18.30 | 111 | .01 | .01 | .01 | 20. |
| 1.01 | 6.40 | 40 | .03 | .00 | .03 | 1. | 1.01 | 18.40 | 112 | .01 | .01 | .01 | 19. |
| 1.01 | 6.50 | 41 | .03 | .00 | .03 | 2. | 1.01 | 18.50 | 113 | .01 | .01 | .01 | 18. |
| 1.01 | 7.00 | 42 | .03 | .00 | .03 | 2. | 1.01 | 19.00 | 114 | .01 | .01 | .01 | 17. |
| 1.01 | 7.10 | 43 | .03 | .00 | .03 | 2. | 1.01 | 19.10 | 115 | .01 | .01 | .01 | 15. |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.01 | 7.20 | 44 | .03 | .00 | .03 | 2. | 1.01 | 19.20 | 116 | .01 | .01 | .01 | 14. |
| 1.01 | 7.30 | 45 | .03 | .00 | .03 | 2. | 1.01 | 19.30 | 117 | .01 | .01 | .01 | 13. |
| 1.01 | 7.40 | 46 | .03 | .00 | .03 | 2. | 1.01 | 19.40 | 118 | .01 | .01 | .01 | 13. |
| 1.01 | 7.50 | 47 | .03 | .00 | .03 | 2. | 1.01 | 19.50 | 119 | .01 | .01 | .01 | 12. |
| 1.01 | 8.00 | 48 | .03 | .00 | .03 | 2. | 1.01 | 20.00 | 120 | .01 | .01 | .01 | 12. |
| 1.01 | 8.10 | 49 | .03 | .00 | .03 | 2. | 1.01 | 20.10 | 121 | .01 | .01 | .01 | 12. |
| 1.01 | 8.20 | 50 | .03 | .00 | .03 | 2. | 1.01 | 20.20 | 122 | .01 | .01 | .01 | 11. |
| 1.01 | 8.30 | 51 | .03 | .00 | .03 | 2. | 1.01 | 20.30 | 123 | .01 | .01 | .01 | 11. |
| 1.01 | 8.40 | 52 | .03 | .00 | .03 | 2. | 1.01 | 20.40 | 124 | .01 | .01 | .01 | 11. |
| 1.01 | 8.50 | 53 | .03 | .00 | .03 | 2. | 1.01 | 20.50 | 125 | .01 | .01 | .01 | 11. |
| 1.01 | 9.00 | 54 | .03 | .00 | .03 | 2. | 1.01 | 21.00 | 126 | .01 | .01 | .01 | 11. |
| 1.01 | 9.10 | 55 | .04 | .00 | .04 | 2. | 1.01 | 21.10 | 127 | .01 | .01 | .01 | 11. |
| 1.01 | 9.20 | 56 | .04 | .00 | .04 | 2. | 1.01 | 21.20 | 128 | .01 | .01 | .01 | 11. |
| 1.01 | 9.30 | 57 | .04 | .00 | .04 | 2. | 1.01 | 21.30 | 129 | .01 | .01 | .01 | 11. |
| 1.01 | 9.40 | 58 | .04 | .00 | .04 | 2. | 1.01 | 21.40 | 130 | .01 | .01 | .01 | 11. |
| 1.01 | 9.50 | 59 | .04 | .00 | .04 | 3. | 1.01 | 21.50 | 131 | .01 | .01 | .01 | 11. |
| 1.01 | 10.00 | 60 | .04 | .00 | .04 | 3. | 1.01 | 22.00 | 132 | .01 | .01 | .01 | 11. |
| 1.01 | 10.10 | 61 | .04 | .00 | .04 | 3. | 1.01 | 22.10 | 133 | .01 | .01 | .01 | 11. |
| 1.01 | 10.20 | 62 | .04 | .00 | .04 | 3. | 1.01 | 22.20 | 134 | .01 | .01 | .01 | 11. |
| 1.01 | 10.30 | 63 | .04 | .00 | .04 | 3. | 1.01 | 22.30 | 135 | .01 | .01 | .01 | 11. |
| 1.01 | 10.40 | 64 | .06 | .00 | .06 | 3. | 1.01 | 22.40 | 136 | .01 | .01 | .01 | 11. |
| 1.01 | 10.50 | 65 | .06 | .00 | .06 | 3. | 1.01 | 22.50 | 137 | .01 | .01 | .01 | 11. |
| 1.01 | 11.00 | 66 | .06 | .00 | .06 | 3. | 1.01 | 23.00 | 138 | .01 | .01 | .01 | 11. |
| 1.01 | 11.10 | 67 | .12 | .01 | .11 | 4. | 1.01 | 23.10 | 139 | .01 | .01 | .01 | 11. |
| 1.01 | 11.20 | 68 | .12 | .01 | .11 | 4. | 1.01 | 23.20 | 140 | .01 | .01 | .01 | 11. |
| 1.01 | 11.30 | 69 | .12 | .01 | .11 | 4. | 1.01 | 23.30 | 141 | .01 | .01 | .01 | 11. |
| 1.01 | 11.40 | 70 | .26 | .02 | .25 | 5. | 1.01 | 23.40 | 142 | .01 | .01 | .01 | 11. |
| 1.01 | 11.50 | 71 | .38 | .04 | .34 | 6. | 1.01 | 23.50 | 143 | .01 | .01 | .01 | 11. |
| 1.01 | 12.00 | 72 | .80 | .16 | .64 | 10. | 1.02 | 0.00 | 144 | .01 | .01 | .01 | 11. |
| | | | | | | | | | SUM | 7.21 | 2.03 | 5.19 | 2679. |
| | | | | | | | | | | ( 183.)( | 51.)( | 132.)( | 75.86) |

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 147. | 57. | 19. | 19. | 2671. |
| CMS | 4. | 2. | 1. | 1. | 76. |
| INCHES | | 1.55 | 1.99 | 1.99 | 1.99 |
| MM | | 38.93 | 50.54 | 50.54 | 50.54 |
| AC-FT | | 28. | 37. | 37. | 37. |
| THOUS CU M | | 35. | 45. | 45. | 45. |

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HYDROGRAPH ROUTING

ROUTING THROUGH SPILLWAY

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|
| POND 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |

ROUTING DATA

| QLOSS | CLOSS | AVG | IRES | ISAME | IOPT | IPMP | LSTR |
|---|---|---|---|---|---|---|---|
| 0.0 | 0.001 | 0.00 | 1 | 0 | 0 | 0 | 0 |

| NSTPS | NSTDL | LAG | AMSKK | X | TSK | STORA | ISPRAT |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0.000 | 0.200 | 0.000 | -900. | -1 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| STAGE | 900.00 | 901.00 | 902.00 | 903.00 | 904.00 | 904.50 | 904.60 | 905.00 | 905.50 | 906.50 |
| FLOW | 0.00 | 15.00 | 54.00 | 115.00 | 208.00 | 270.00 | 350.00 | 980.00 | 2210.00 | 5720.00 |
| SURFACE AREA= | 5. | 7. | 9. | 10. | 11. | 12. | 14. | | | |
| CAPACITY= | 0. | 18. | 36. | 46. | 55. | 64. | 83. | | | |
| ELEVATION= | 897. | 900. | 902. | 903. | 904. | 905. | 906. | | | |

| CREL | SPWID | COQW | EXPW | ELEVL | COQL | CAREA | EXPL |
|---|---|---|---|---|---|---|---|
| 900.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

DAM DATA

| TOPEL | COQD | EXPD | DAMWID |
|---|---|---|---|
| 904.5 | 0.0 | 0.0 | 0. |

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

RUNOFF TO LOWER DAM, 100-YR FLOOD BASED ON SULLIVAN PRECIP, 10-MIN. INCR.

| | ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|---|
| | INFLOW | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |

HYDROGRAPH DATA

| IHYDG | TUHG | TAREA | SNAP | TRSDA | TRSPC | RATIO | ISNOW | ISAME | LOCAL |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 2 | .06 | 0.00 | .06 | 0.00 | 0.000 | 0 | 0 | 0 |

PRECIP DATA

| NP | STORM | DAJ | DAK |
|---|---|---|---|
| -100 | 0.00 | 0.00 | 0.00 |

LOSS DATA

| LROPT | STRKR | DLTKR | RTIOL | ERAIN | STRKS | RTIOK | STRTL | CNSTL | ALSMX | RTIMP |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | 1.00 | -1.00 | -100.00 | 0.00 | 0.00 |

CURVE NO = -100.00 WETNESS = -1.00 EFFECT CN = 100.00

UNIT HYDROGRAPH DATA

TC= 0.00 LAG= .10

RECESSION DATA

STRTQ= -.01 QRCSN= -.01 RTIOR= 1.00

TIME INCREMENT TOO LARGE--(NHQ IS GT LAG/2)

UNIT HYDROGRAPH 5 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .10 VOL= 1.00

154. 59. 14. 3. 1.

0

END-OF-PERIOD FLOW

| MO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | COMP Q | MO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | COMP Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.01 | .10 | 1 | .01 | .01 | .00 | 2. | 1.01 | 12.10 | 73 | 1.21 | 1.21 | .00 | 238. |
| 1.01 | .20 | 2 | .01 | .01 | .00 | 3. | 1.01 | 12.20 | 74 | .38 | .38 | -.00 | 142. |
| 1.01 | .30 | 3 | .01 | .01 | 0.00 | 3. | 1.01 | 12.30 | 75 | .26 | .26 | -.00 | 82. |
| 1.01 | .40 | 4 | .01 | .01 | .00 | 3. | 1.01 | 12.40 | 76 | .12 | .12 | -.00 | 44. |
| 1.01 | .50 | 5 | .01 | .01 | .00 | 3. | 1.01 | 12.50 | 77 | .12 | .12 | -.00 | 32. |
| 1.01 | 1.00 | 6 | .01 | .01 | -.00 | 3. | 1.01 | 13.00 | 78 | .12 | .12 | -.00 | 29. |
| 1.01 | 1.10 | 7 | .01 | .01 | -.00 | 3. | 1.01 | 13.10 | 79 | .06 | .06 | -.00 | 19. |
| 1.01 | 1.20 | 8 | .01 | .01 | -.00 | 3. | 1.01 | 13.20 | 80 | .06 | .06 | .00 | 15. |
| 1.01 | 1.30 | 9 | .01 | .01 | .00 | 3. | 1.01 | 13.30 | 81 | .06 | .06 | -.00 | 14. |
| 1.01 | 1.40 | 10 | .01 | .01 | -.00 | 3. | 1.01 | 13.40 | 82 | .04 | .04 | .00 | 12. |
| 1.01 | 1.50 | 11 | .01 | .01 | -.00 | 3. | 1.01 | 13.50 | 83 | .04 | .04 | -.00 | 10. |
| 1.01 | 2.00 | 12 | .01 | .01 | -.00 | 3. | 1.01 | 14.00 | 84 | .04 | .04 | -.00 | 10. |
| 1.01 | 2.10 | 13 | .01 | .01 | .00 | 3. | 1.01 | 14.10 | 85 | .04 | .04 | .00 | 10. |
| 1.01 | 2.20 | 14 | .01 | .01 | -.00 | 3. | 1.01 | 14.20 | 86 | .04 | .04 | -.00 | 10. |
| 1.01 | 2.30 | 15 | .01 | .01 | -.00 | 3. | 1.01 | 14.30 | 87 | .04 | .04 | .00 | 10. |
| 1.01 | 2.40 | 16 | .01 | .01 | -.00 | 3. | 1.01 | 14.40 | 88 | .04 | .04 | -.00 | 10. |
| 1.01 | 2.50 | 17 | .01 | .01 | -.00 | 3. | 1.01 | 14.50 | 89 | .04 | .04 | -.00 | 10. |
| 1.01 | 3.00 | 18 | .01 | .01 | .00 | 3. | 1.01 | 15.00 | 90 | .04 | .04 | .00 | 10. |
| 1.01 | 3.10 | 19 | .01 | .01 | .00 | 3. | 1.01 | 15.10 | 91 | .03 | .03 | -.00 | 8. |
| 1.01 | 3.20 | 20 | .01 | .01 | .00 | 3. | 1.01 | 15.20 | 92 | .03 | .03 | .00 | 7. |
| 1.01 | 3.30 | 21 | .01 | .01 | .00 | 3. | 1.01 | 15.30 | 93 | .03 | .03 | .00 | 6. |
| 1.01 | 3.40 | 22 | .01 | .01 | .00 | 3. | 1.01 | 15.40 | 94 | .03 | .03 | -.00 | 6. |
| 1.01 | 3.50 | 23 | .01 | .01 | .00 | 3. | 1.01 | 15.50 | 95 | .03 | .03 | .00 | 6. |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.01 | 4.00 | 24 | .01 | .01 | .00 | 3. | 1.01 | 16.00 | 96 | .03 | .03 | .00 | 6. |
| 1.01 | 4.10 | 25 | .01 | .01 | .00 | 3. | 1.01 | 16.10 | 97 | .03 | .03 | -.00 | 6. |
| 1.01 | 4.20 | 26 | .01 | .01 | .00 | 3. | 1.01 | 16.20 | 98 | .03 | .03 | .00 | 6. |
| 1.01 | 4.30 | 27 | .01 | .01 | .00 | 3. | 1.01 | 16.30 | 99 | .03 | .03 | -.00 | 6. |
| 1.01 | 4.40 | 28 | .01 | .01 | .00 | 3. | 1.01 | 16.40 | 100 | .03 | .03 | .00 | 6. |
| 1.01 | 4.50 | 29 | .01 | .01 | .00 | 3. | 1.01 | 16.50 | 101 | .03 | .03 | .00 | 6. |
| 1.01 | 5.00 | 30 | .01 | .01 | -.00 | 3. | 1.01 | 17.00 | 102 | .03 | .03 | .00 | 6. |
| 1.01 | 5.10 | 31 | .01 | .01 | .00 | 3. | 1.01 | 17.10 | 103 | .03 | .03 | .00 | 6. |
| 1.01 | 5.20 | 32 | .01 | .01 | -.00 | 3. | 1.01 | 17.20 | 104 | .03 | .03 | .00 | 6. |
| 1.01 | 5.30 | 33 | .01 | .01 | .00 | 3. | 1.01 | 17.30 | 105 | .03 | .03 | .00 | 6. |
| 1.01 | 5.40 | 34 | .01 | .01 | -.00 | 3. | 1.01 | 17.40 | 106 | .03 | .03 | .00 | 6. |
| 1.01 | 5.50 | 35 | .01 | .01 | .00 | 3. | 1.01 | 17.50 | 107 | .03 | .03 | -.00 | 6. |
| 1.01 | 6.00 | 36 | .01 | .01 | .00 | 3. | 1.01 | 18.00 | 108 | .03 | .03 | .00 | 6. |
| 1.01 | 6.10 | 37 | .03 | .03 | .00 | 5. | 1.01 | 18.10 | 109 | .01 | .01 | -.00 | 4. |
| 1.01 | 6.20 | 38 | .03 | .03 | .00 | 6. | 1.01 | 18.20 | 110 | .01 | .01 | -.00 | 3. |
| 1.01 | 6.30 | 39 | .03 | .03 | .00 | 6. | 1.01 | 18.30 | 111 | .01 | .01 | -.00 | 3. |
| 1.01 | 6.40 | 40 | .03 | .03 | .00 | 6. | 1.01 | 18.40 | 112 | .01 | .01 | -.00 | 3. |
| 1.01 | 6.50 | 41 | .03 | .03 | .00 | 6. | 1.01 | 18.50 | 113 | .01 | .01 | -.00 | 3. |
| 1.01 | 7.00 | 42 | .03 | .03 | .00 | 6. | 1.01 | 19.00 | 114 | .01 | .01 | .00 | 3. |
| 1.01 | 7.10 | 43 | .03 | .03 | .00 | 6. | 1.01 | 19.10 | 115 | .01 | .01 | -.00 | 3. |
| 1.01 | 7.20 | 44 | .03 | .03 | .00 | 6. | 1.01 | 19.20 | 116 | .01 | .01 | -.00 | 3. |
| 1.01 | 7.30 | 45 | .03 | .03 | .00 | 6. | 1.01 | 19.30 | 117 | .01 | .01 | -.00 | 3. |
| 1.01 | 7.40 | 46 | .03 | .03 | -.00 | 6. | 1.01 | 19.40 | 118 | .01 | .01 | -.00 | 3. |
| 1.01 | 7.50 | 47 | .03 | .03 | .00 | 6. | 1.01 | 19.50 | 119 | .01 | .01 | -.00 | 3. |
| 1.01 | 8.00 | 48 | .03 | .03 | .00 | 6. | 1.01 | 20.00 | 120 | .01 | .01 | .00 | 3. |
| 1.01 | 8.10 | 49 | .03 | .03 | .00 | 6. | 1.01 | 20.10 | 121 | .01 | .01 | -.00 | 3. |
| 1.01 | 8.20 | 50 | .03 | .03 | -.00 | 6. | 1.01 | 20.20 | 122 | .01 | .01 | .00 | 3. |
| 1.01 | 8.30 | 51 | .03 | .03 | .00 | 6. | 1.01 | 20.30 | 123 | .01 | .01 | -.00 | 3. |
| 1.01 | 8.40 | 52 | .03 | .03 | .00 | 6. | 1.01 | 20.40 | 124 | .01 | .01 | -.00 | 3. |
| 1.01 | 8.50 | 53 | .03 | .03 | .00 | 6. | 1.01 | 20.50 | 125 | .01 | .01 | .00 | 3. |
| 1.01 | 9.00 | 54 | .03 | .03 | .00 | 6. | 1.01 | 21.00 | 126 | .01 | .01 | -.00 | 3. |
| 1.01 | 9.10 | 55 | .04 | .04 | .00 | 9. | 1.01 | 21.10 | 127 | .01 | .01 | -.00 | 3. |
| 1.01 | 9.20 | 56 | .04 | .04 | .00 | 10. | 1.01 | 21.20 | 128 | .01 | .01 | .00 | 3. |
| 1.01 | 9.30 | 57 | .04 | .04 | .00 | 10. | 1.01 | 21.30 | 129 | .01 | .01 | -.00 | 3. |
| 1.01 | 9.40 | 58 | .04 | .04 | .00 | 10. | 1.01 | 21.40 | 130 | .01 | .01 | -.00 | 3. |
| 1.01 | 9.50 | 59 | .04 | .04 | .00 | 10. | 1.01 | 21.50 | 131 | .01 | .01 | -.00 | 3. |
| 1.01 | 10.00 | 60 | .04 | .04 | .00 | 10. | 1.01 | 22.00 | 132 | .01 | .01 | -.00 | 3. |
| 1.01 | 10.10 | 61 | .04 | .04 | .00 | 10. | 1.01 | 22.10 | 133 | .01 | .01 | .00 | 3. |
| 1.01 | 10.20 | 62 | .04 | .04 | .00 | 10. | 1.01 | 22.20 | 134 | .01 | .01 | -.00 | 3. |
| 1.01 | 10.30 | 63 | .04 | .04 | .00 | 10. | 1.01 | 22.30 | 135 | .01 | .01 | -.00 | 3. |
| 1.01 | 10.40 | 64 | .06 | .06 | .00 | 13. | 1.01 | 22.40 | 136 | .01 | .01 | -.00 | 3. |
| 1.01 | 10.50 | 65 | .06 | .06 | -.00 | 14. | 1.01 | 22.50 | 137 | .01 | .01 | -.00 | 3. |
| 1.01 | 11.00 | 66 | .06 | .06 | .00 | 14. | 1.01 | 23.00 | 138 | .01 | .01 | .00 | 3. |
| 1.01 | 11.10 | 67 | .12 | .12 | 0.00 | 23. | 1.01 | 23.10 | 139 | .01 | .01 | -.00 | 3. |
| 1.01 | 11.20 | 68 | .12 | .12 | 0.00 | 27. | 1.01 | 23.20 | 140 | .01 | .01 | -.00 | 3. |
| 1.01 | 11.30 | 69 | .12 | .12 | .00 | 28. | 1.01 | 23.30 | 141 | .01 | .01 | .00 | 3. |
| 1.01 | 11.40 | 70 | .26 | .26 | .00 | 50. | 1.01 | 23.40 | 142 | .01 | .01 | -.00 | 3. |
| 1.01 | 11.50 | 71 | .38 | .38 | -.00 | 77. | 1.01 | 23.50 | 143 | .01 | .01 | -.00 | 3. |
| 1.01 | 12.00 | 72 | .80 | .80 | -.00 | 150. | 1.02 | 0.00 | 144 | .01 | .01 | .00 | 3. |
| | | | | | | | | | SUM | 7.21 | 7.21 | .00 | 1626. |
| | | | | | | | | | | ( 183.1( | 183.1( | 0.1( | 46.04) |

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 238. | 33. | 11. | 11. | 1654. |
| CMS | 7. | 1. | 0. | 0. | 47. |
| INCHES | | 5.19 | 7.20 | 7.20 | 7.20 |
| MM | | 131.79 | 182.80 | 182.80 | 182.80 |
| AC-FT | | 16. | 23. | 23. | 23. |
| THOUS CU M | | 20. | 28. | 28. | 28. |

**********  **********  **********  **********  **********

COMBINE HYDROGRAPHS

COMBINATION OF OUTFLOW FROM UPPER DIKE AND RUNOFF FROM LOWER WATERSHED

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|
| UP+LOW | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

SUM OF 2 HYDROGRAPHS ATUP+LOW

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2. | 3. | 5. | 4. | 4. | 4. | 4. | 4. | 4. |
| 4. | 4. | 4. | 4. | 4. | 4. | 4. | 4. | 4. |
| 4. | 4. | 4. | 4. | 4. | 4. | 4. | 4. | 4. |
| 4. | 4. | 4. | 4. | 4. | 4. | 7. | 8. | 8. |
| 8. | 8. | 8. | 8. | 8. | 8. | 8. | 8. | 8. |
| 8. | 8. | 8. | 8. | 10. | 11. | 12. | 12. | 12. |
| 12. | 12. | 12. | 15. | 16. | 16. | 25. | 29. | 30. |
| 79. | 152. | 241. | 146. | 87. | 51. | 41. | 42. | 37. |
| 48. | 51. | 55. | 58. | 60. | 61. | 62. | 62. | 62. |
| 59. | 57. | 56. | 55. | 54. | 53. | 52. | 51. | 50. |
| 47. | 46. | 45. | 44. | 43. | 42. | 41. | 40. | 37. |
| 35. | 34. | 33. | 32. | 31. | 31. | 30. | 29. | 28. |
| 26. | 26. | 25. | 24. | 24. | 23. | 22. | 22. | 21. |
| 20. | 20. | 20. | 19. | 19. | 18. | 18. | 18. | 18. |
| 18. | 18. | 18. | 17. | | | | | |

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 241. | 64. | 27. | 27. | 3819. |
| CMS | 7. | 2. | 1. | 1. | 108. |
| INCHES | | 1.47 | 2.43 | 2.43 | 2.43 |
| MM | | 37.32 | 61.70 | 61.70 | 61.70 |
| AC-FT | | 32. | 53. | 53. | 53. |
| THOUS CU M | | 39. | 65. | 65. | 65. |

**********  **********  **********  **********  **********

HYDROGRAPH ROUTING

ROUTING THROUGH LAKE, CLOSED SYSTEM

| | TSTAG | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|---|
| | POND 2 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |

ROUTING DATA

| QLOSS | CLOSS | AVG | IRES | ISAME | IOPT | IPMP | | LSTR |
|---|---|---|---|---|---|---|---|---|
| 0.0 | 0.000 | 0.00 | 1 | 0 | 0 | 0 | | 0 |
| | NSTPS | NSTDI | LAG | AMSKK | X | TSK | STORA | ISPRAT |
| | 1 | 0 | 0 | 0.000 | 0.000 | 0.000 | -897. | -1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| STAGE | 897.70 | 898.00 | 898.50 | 899.00 | 899.50 | 900.00 |
| FLOW | 0.00 | 25.00 | 165.00 | 425.00 | 825.00 | 1350.00 |
| SURFACE AREA= | 0. | 3. | 10. | 14. | 18. | 22. |
| CAPACITY= | 0. | 2. | 14. | 26. | 42. | 62. |
| ELEVATION= | 893. | 895. | 897. | 898. | 899. | 900. |

| CREL | SPWID | COOW | EXPW | FLEVL | COGL | CAREA | EXPL |
|---|---|---|---|---|---|---|---|
| 897.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

DAM DATA

| TOPEL | COQD | EXPD | DAMWID |
|---|---|---|---|
| 897.7 | 0.0 | 0.0 | 0. |

RUNOFF SUMMARY, AVERAGE FLOW IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES(SQUARE KILOMETERS)

| | | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | AREA |
|---|---|---|---|---|---|---|
| HYDROGRAPH AT | INFLOW | 147. | 57. | 19. | 19. | .35 |
| | ( | 4.16)( | 1.62)( | .53)( | .53)( | .90) |
| ROUTED TO | POND 1 | 52. | 41. | 15. | 15. | .35 |
| | ( | 1.48)( | 1.17)( | .43)( | .43)( | .90) |
| HYDROGRAPH AT | INFLOW | 238. | 33. | 11. | 1. | .06 |
| | ( | 6.75)( | .94)( | .33)( | .33)( | .15) |
| 2-COMBINED | UP+LOW | 241. | 64. | 27. | 27. | .41 |
| | ( | 6.83)( | 1.82)( | .75)( | .75)( | 1.05) |
| ROUTED TO | POND 2 | 69. | 54. | 20. | 20. | .41 |
| | ( | 1.95)( | 1.53)( | .58)( | .58)( | 1.05) |



SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 100-yr.

| | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 900.00 | 900.00 | 904.50 |
| STORAGE | 18. | 18. | 59. |
| OUTFLOW | 0. | 0. | 270. |

| MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|
| 901.96 | 0.00 | 33. | 52. | 0.00 | 14.67 | 0.00 |

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 100-yr.

| | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 896.90 | 897.70 | 897.70 |
| STORAGE | 13. | 22. | 22. |
| OUTFLOW | 0. | 0. | 0. |

| MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|
| 898.16 | .46 | 28. | 69. | 12.17 | 12.67 | 0.00 |

```
A1         BLACK DAM, ID. NO. 31154
A2         HEC-1  PHASE 1 DAM SAFETY INVESTIGATION
A3         10 -YEAR FLOOD
B     144                  10
B1      3
K       0  INFLOW                                    1         1
K1    RUNOFF TO UPPER DIKE, 10 -YR FLOOD BASED ON SULLIVAN PRECIP. 10-MIN. INCR.
M       0         2  0.3469
O     144
O1    .01       .01       .01       .01       .01       .01       .01       .01       .01       .01
O1    .01       .01       .01       .01       .01       .01       .01       .01       .01       .01
O1    .01       .01       .01       .01       .01       .01       .01       .01       .01       .01
O1    .01       .01       .01       .01       .01       .01       .02       .02       .02       .02
O1    .02       .02       .02       .02       .02       .02       .02       .02       .02       .02
O1    .02       .02       .02       .02       .03       .03       .03       .03       .03       .03
O1    .03       .03       .03       .062      .062      .062      .098      .098      .098      .172
O1    .249      .538      .846      .249      .172      .098      .098      .098      .062      .062
O1    .062      .03       .03       .03       .03       .03       .03       .03       .03       .03
O1    .02       .02       .02       .02       .02       .02       .02       .02       .02       .02
O1    .02       .02       .02       .02       .02       .02       .02       .02       .01       .01
O1    .01       .01       .01       .01       .01       .01       .01       .01       .01       .01
O1    .01       .01       .01       .01       .01       .01       .01       .01       .01       .01
O1    .01       .01       .01       .01       .01       .01       .01       .01       .01       .01
O1    .01       .01       .01       .01
T                                                                 -1       -49                 .06
W2                .98
X     -10         -.1       2.5
K       1  POND 1                                          1         1
K1    ROUTING THROUGH SPILLWAY
Y                                       1
Y1      1                                                           -900        -1
Y4  900.0     901.0     902.0     903.0     904.0     904.5     904.6     905.0     905.5     906.5
Y5      0        15        54       115       208       270       350       980      2210      5720
$A      5         7         9        10        11        12        14
$E    897       900     902.3     903.3     904.2       905     906.4
$$    900
$D  904.5
```

```
K       0  INFLOW                                                    1        1
K1    RUNOFF TO LOWER DAM, 10 -YR FLOOD BASED ON SULLIVAN PRECIP. 10-MIN. INCR.
M       0        2    .0594
O    -144                                                          -1     -100
T
N2              0.1
X    -.01     -.01        1
K       2  UP+LOW
K1    COMBINATION OF OUTFLOW FROM UPPER DIKE AND RUNOFF FROM LOWER WATERSHED
K       1  POND 2                                                    1        1
K1    ROUTING THROUGH LAKE, CLOSED SYSTEM
Y                                    1                          -896.9       -1
Y1      1
Y4  897.7    898.0    898.5    899.0    899.5    900.0
Y5      0       25      165      425      825     1350
$A      0        5       10       14       18       22
$E    893      895      897      898      899      900
$$  897.7
$D  897.7
K      99
A
A
A
```

```
**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION       JULY 1978
  LAST MODIFICATION  26 FEB 79
**********************************

RUN  DATE= 79/08/09.
     TIME= 13.35.32.
```

BLACK DAM, ID. NO. 31154
HEC-1 PHASE 1 DAM SAFETY INVESTIGATION
10 -YEAR FLOOD

JOB SPECIFICATION

| NQ | NHR | NMIN | IDAY | IHR | IMIN | METRC | IPLT | IPRT | NSTAN |
|---|---|---|---|---|---|---|---|---|---|
| 144 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | JOPER | NWT | LROPT | TRACE | | | |
| | | | 3 | 0 | 0 | 0 | | | |

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

RUNOFF TO UPPER DIKE, 100-YR FLOOD BASED ON SULLIVAN PRECIP. 10-MIN. INCR.

| | ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|---|
| INFLOW | | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |

HYDROGRAPH DATA

| IHYDG | IUHG | TAREA | SNAP | TRSDA | TRSPC | RATIO | ISNOW | ISAME | LOCAL |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 2 | .35 | 0.00 | .35 | 0.00 | 0.000 | 0 | 0 | 0 |

PRECIP DATA

| | NP | STORM | DAJ | DAK |
|---|---|---|---|---|
| | 144 | 0.00 | 0.00 | 0.00 |

PRECIP PATTERN

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 |
| .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 |
| .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 |
| .01 | .01 | .01 | .01 | .01 | .01 | .02 | .02 | .02 | .02 |
| .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 |
| .02 | .02 | .02 | .02 | .03 | .03 | .03 | .03 | .03 | .03 |
| .03 | .03 | .03 | .06 | .06 | .06 | .10 | .10 | .10 | .17 |
| .25 | .55 | .85 | .25 | .17 | .10 | .10 | .10 | .06 | .06 |
| .06 | .03 | .03 | .03 | .03 | .03 | .03 | .03 | .03 | .03 |
| .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 |
| .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .01 | .01 |
| .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 |
| .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 |
| .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 |
| .01 | .01 | .01 | .01 | | | | | | |

LOSS DATA

| LROPT | STRKR | DLTKR | RTIOL | ERAIN | STRKS | RTIOK | STRTL | CNSTL | ALSMX | RTIMP |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | 1.00 | -1.00 | -49.00 | 0.00 | .06 |

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= .98

RECESSION DATA
STRTQ= -10.00 QRCSN= -.10 RTIOR= 2.50

UNIT HYDROGRAPH 51 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .98 VOL= 1.00

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 11. | 32. | 67. | 111. | 144. | 157. | 156. | 141. | 121. | 94. |
| 70. | 54. | 42. | 33. | 25. | 20. | 15. | 12. | 9. | 7. |
| 6. | 4. | 3. | 3. | 2. | 2. | 1. | 1. | 1. | 0. |
| 0. | | | | | | | | | |

0 END-OF-PERIOD FLOW

| MO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | COMP Q | MO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | COMP Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.01 | .10 | 1 | .01 | .00 | .01 | 3. | 1.01 | 12.10 | 73 | .85 | .16 | .69 | 10. |
| 1.01 | .20 | 2 | .01 | .00 | .01 | 3. | 1.01 | 12.20 | 74 | .25 | .06 | .18 | 10. |
| 1.01 | .30 | 3 | .01 | .00 | .01 | 3. | 1.01 | 12.30 | 75 | .17 | .05 | .12 | 25. |
| 1.01 | .40 | 4 | .01 | .00 | .01 | 3. | 1.01 | 12.40 | 76 | .10 | .03 | .07 | 37. |
| 1.01 | .50 | 5 | .01 | .00 | .01 | 2. | 1.01 | 12.50 | 77 | .10 | .03 | .07 | 47. |
| 1.01 | 1.00 | 6 | .01 | .00 | .01 | 2. | 1.01 | 13.00 | 78 | .10 | .03 | .07 | 54. |
| 1.01 | 1.10 | 7 | .01 | .00 | .01 | 2. | 1.01 | 13.10 | 79 | .06 | .02 | .04 | 58. |
| 1.01 | 1.20 | 8 | .01 | .00 | .01 | 2. | 1.01 | 13.20 | 80 | .06 | .02 | .04 | 59. |
| 1.01 | 1.30 | 9 | .01 | .00 | .01 | 2. | 1.01 | 13.30 | 81 | .06 | .02 | .04 | 57. |
| 1.01 | 1.40 | 10 | .01 | .00 | .01 | 2. | 1.01 | 13.40 | 82 | .03 | .01 | .02 | 53. |
| 1.01 | 1.50 | 11 | .01 | .00 | .01 | 2. | 1.01 | 13.50 | 83 | .03 | .01 | .02 | 48. |
| 1.01 | 2.00 | 12 | .01 | .00 | .01 | 2. | 1.01 | 14.00 | 84 | .03 | .01 | .02 | 43. |
| 1.01 | 2.10 | 13 | .01 | .00 | .01 | 2. | 1.01 | 14.10 | 85 | .03 | .01 | .02 | 39. |
| 1.01 | 2.20 | 14 | .01 | .00 | .01 | 2. | 1.01 | 14.20 | 86 | .03 | .01 | .02 | 34. |
| 1.01 | 2.30 | 15 | .01 | .00 | .01 | 2. | 1.01 | 14.30 | 87 | .03 | .01 | .02 | 31. |
| 1.01 | 2.40 | 16 | .01 | .00 | .01 | 2. | 1.01 | 14.40 | 88 | .03 | .01 | .02 | 27. |
| 1.01 | 2.50 | 17 | .01 | .00 | .01 | 2. | 1.01 | 14.50 | 89 | .03 | .01 | .02 | 24. |
| 1.01 | 3.00 | 18 | .01 | .00 | .01 | 1. | 1.01 | 15.00 | 90 | .03 | .01 | .02 | 22. |
| 1.01 | 3.10 | 19 | .01 | .00 | .01 | 1. | 1.01 | 15.10 | 91 | .02 | .01 | .01 | 20. |
| 1.01 | 3.20 | 20 | .01 | .00 | .01 | 1. | 1.01 | 15.20 | 92 | .02 | .01 | .01 | 19. |
| 1.01 | 3.30 | 21 | .01 | .00 | .01 | 1. | 1.01 | 15.30 | 93 | .02 | .01 | .01 | 18. |
| 1.01 | 3.40 | 22 | .01 | .00 | .01 | 1. | 1.01 | 15.40 | 94 | .02 | .01 | .01 | 17. |
| 1.01 | 3.50 | 23 | .01 | .00 | .01 | 1. | 1.01 | 15.50 | 95 | .02 | .01 | .01 | 16. |
| 1.01 | 4.00 | 24 | .01 | .00 | .01 | 1. | 1.01 | 16.00 | 96 | .02 | .01 | .01 | 15. |
| 1.01 | 4.10 | 25 | .01 | .00 | .01 | 1. | 1.01 | 16.10 | 97 | .02 | .01 | .01 | 14. |
| 1.01 | 4.20 | 26 | .01 | .00 | .01 | 1. | 1.01 | 16.20 | 98 | .02 | .01 | .01 | 13. |
| 1.01 | 4.30 | 27 | .01 | .00 | .01 | 1. | 1.01 | 16.30 | 99 | .02 | .01 | .01 | 12. |
| 1.01 | 4.40 | 28 | .01 | .00 | .01 | 1. | 1.01 | 16.40 | 100 | .02 | .01 | .01 | 12. |
| 1.01 | 4.50 | 29 | .01 | .00 | .01 | 1. | 1.01 | 16.50 | 101 | .02 | .01 | .01 | 12. |
| 1.01 | 5.00 | 30 | .01 | .00 | .01 | 1. | 1.01 | 17.00 | 102 | .02 | .01 | .01 | 11. |
| 1.01 | 5.10 | 31 | .01 | .00 | .01 | 1. | 1.01 | 17.10 | 103 | .02 | .01 | .01 | 11. |
| 1.01 | 5.20 | 32 | .01 | .00 | .01 | 1. | 1.01 | 17.20 | 104 | .02 | .01 | .01 | 11. |
| 1.01 | 5.30 | 33 | .01 | .00 | .01 | 1. | 1.01 | 17.30 | 105 | .02 | .01 | .01 | 11. |
| 1.01 | 5.40 | 34 | .01 | .00 | .01 | 1. | 1.01 | 17.40 | 106 | .02 | .01 | .01 | 11. |
| 1.01 | 5.50 | 35 | .01 | .00 | .01 | 1. | 1.01 | 17.50 | 107 | .02 | .01 | .01 | 11. |
| 1.01 | 6.00 | 36 | .01 | .00 | .01 | 1. | 1.01 | 18.00 | 108 | .02 | .01 | .01 | 11. |
| 1.01 | 6.10 | 37 | .02 | .00 | .02 | 1. | 1.01 | 18.10 | 109 | .01 | .00 | .01 | 11. |
| 1.01 | 6.20 | 38 | .02 | .00 | .02 | 1. | 1.01 | 18.20 | 110 | .01 | .00 | .01 | 11. |
| 1.01 | 6.30 | 39 | .02 | .00 | .02 | 1. | 1.01 | 18.30 | 111 | .01 | .00 | .01 | 10. |
| 1.01 | 6.40 | 40 | .02 | .00 | .02 | 1. | 1.01 | 18.40 | 112 | .01 | .00 | .01 | 10. |
| 1.01 | 6.50 | 41 | .02 | .00 | .02 | 1. | 1.01 | 18.50 | 113 | .01 | .00 | .01 | 9. |
| 1.01 | 7.00 | 42 | .02 | .00 | .02 | 1. | 1.01 | 19.00 | 114 | .01 | .00 | .01 | 9. |
| 1.01 | 7.10 | 43 | .02 | .00 | .02 | 1. | 1.01 | 19.10 | 115 | .01 | .00 | .01 | 8. |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.01 | 7.20 | 44 | .02 | .00 | .02 | 1. | 1.01 | 19.20 | 116 | .01 | .00 | .01 | 6. |
| 1.01 | 7.30 | 45 | .02 | .00 | .02 | 1. | 1.01 | 19.30 | 117 | .01 | .00 | .01 | 7. |
| 1.01 | 7.40 | 46 | .02 | .00 | .02 | 1. | 1.01 | 19.40 | 118 | .01 | .00 | .01 | 7. |
| 1.01 | 7.50 | 47 | .02 | .00 | .02 | 2. | 1.01 | 19.50 | 119 | .01 | .00 | .01 | 6. |
| 1.01 | 8.00 | 48 | .02 | .00 | .02 | 2. | 1.01 | 20.00 | 120 | .01 | .00 | .01 | 6. |
| 1.01 | 8.10 | 49 | .02 | .00 | .02 | 2. | 1.01 | 20.10 | 121 | .01 | .00 | .01 | 6. |
| 1.01 | 8.20 | 50 | .02 | .00 | .02 | 2. | 1.01 | 20.20 | 122 | .01 | .00 | .01 | 6. |
| 1.01 | 8.30 | 51 | .02 | .00 | .02 | 2. | 1.01 | 20.30 | 123 | .01 | .00 | .01 | 6. |
| 1.01 | 8.40 | 52 | .02 | .00 | .02 | 2. | 1.01 | 20.40 | 124 | .01 | .00 | .01 | 6. |
| 1.01 | 8.50 | 53 | .02 | .00 | .02 | 2. | 1.01 | 20.50 | 125 | .01 | .00 | .01 | 6. |
| 1.01 | 9.00 | 54 | .02 | .00 | .02 | 2. | 1.01 | 21.00 | 126 | .01 | .00 | .01 | 6. |
| 1.01 | 9.10 | 55 | .03 | .00 | .03 | 2. | 1.01 | 21.10 | 127 | .01 | .00 | .01 | 6. |
| 1.01 | 9.20 | 56 | .03 | .00 | .03 | 2. | 1.01 | 21.20 | 128 | .01 | .00 | .01 | 6. |
| 1.01 | 9.30 | 57 | .03 | .00 | .03 | 2. | 1.01 | 21.30 | 129 | .01 | .00 | .01 | 6. |
| 1.01 | 9.40 | 58 | .03 | .00 | .03 | 2. | 1.01 | 21.40 | 130 | .01 | .00 | .01 | 6. |
| 1.01 | 9.50 | 59 | .03 | .00 | .03 | 2. | 1.01 | 21.50 | 131 | .01 | .00 | .01 | 6. |
| 1.01 | 10.00 | 60 | .03 | .00 | .03 | 2. | 1.01 | 22.00 | 132 | .01 | .00 | .01 | 6. |
| 1.01 | 10.10 | 61 | .03 | .00 | .03 | 2. | 1.01 | 22.10 | 133 | .01 | .00 | .01 | 6. |
| 1.01 | 10.20 | 62 | .03 | .00 | .03 | 2. | 1.01 | 22.20 | 134 | .01 | .00 | .01 | 6. |
| 1.01 | 10.30 | 63 | .03 | .00 | .03 | 2. | 1.01 | 22.30 | 135 | .01 | .00 | .01 | 6. |
| 1.01 | 10.40 | 64 | .06 | .00 | .06 | 2. | 1.01 | 22.40 | 136 | .01 | .00 | .01 | 6. |
| 1.01 | 10.50 | 65 | .06 | .00 | .06 | 2. | 1.01 | 22.50 | 137 | .01 | .00 | .01 | 6. |
| 1.01 | 11.00 | 66 | .06 | .00 | .06 | 3. | 1.01 | 23.00 | 138 | .01 | .00 | .01 | 6. |
| 1.01 | 11.10 | 67 | .10 | .01 | .09 | 3. | 1.01 | 23.10 | 139 | .01 | .00 | .01 | 6. |
| 1.01 | 11.20 | 68 | .10 | .01 | .09 | 3. | 1.01 | 23.20 | 140 | .01 | .00 | .01 | 6. |
| 1.01 | 11.30 | 69 | .10 | .01 | .09 | 4. | 1.01 | 23.30 | 141 | .01 | .00 | .01 | 6. |
| 1.01 | 11.40 | 70 | .17 | .01 | .16 | 4. | 1.01 | 23.40 | 142 | .01 | .00 | .01 | 6. |
| 1.01 | 11.50 | 71 | .25 | .01 | .23 | 5. | 1.01 | 23.50 | 143 | .01 | .00 | .01 | 6. |
| 1.01 | 12.00 | 72 | .54 | .04 | .50 | 6. | 1.02 | 0.00 | 144 | .01 | .00 | .01 | 6. |
| | | | | | | | | | SUM | 5.17 | .97 | 4.19 | 1308. |
| | | | | | | | | | | ( 131.)( | 25.)( | 107.)( | 37.04) |

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 59. | 26. | 9. | 9. | 1295. |
| CMS | 2. | 1. | 0. | 0. | 37. |
| INCHES | | .69 | .96 | .96 | .96 |
| MM | | 17.54 | 24.50 | 24.50 | 24.50 |
| AC-FT | | 13. | 18. | 18. | 18. |
| THOUS CU M | | 16. | 22. | 22. | 22. |

**********  **********  **********  **********  **********

HYDROGRAPH ROUTING

ROUTING THROUGH SPILLWAY

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|
| POND 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |

ROUTING DATA

| QLOSS | CLOSS | AVG | IRES | ISAME | IOPT | IPMP | | LSTR |
|---|---|---|---|---|---|---|---|---|
| 0.0 | 0.000 | 0.00 | 1 | 0 | 0 | 0 | | 0 |

| NSTPS | NSTOL | LAG | AMSKK | X | TSK | STORA | ISPRAT |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0.000 | 0.000 | 0.000 | -900. | -1 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| FLOW | 0.00 | 15.00 | 54.00 | 115.00 | 208.00 | 270.00 | 350.00 | 980.00 | 2210.00 | 5720.00 |
| SURFACE AREA= | 5. | 7. | 9. | 10. | 11. | 12. | 14. | | | |
| CAPACITY= | 0. | 16. | 36. | 46. | 55. | 64. | 83. | | | |
| ELEVATION= | 897. | 900. | 902. | 903. | 904. | 905. | 906. | | | |

| CREL | SPWID | COOW | EXPW | ELEVL | COOL | CAREA | EXPL |
|---|---|---|---|---|---|---|---|
| 900.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

DAM DATA

| TOPEL | COOD | EXPD | DAMWID |
|---|---|---|---|
| 904.5 | 0.0 | 0.0 | 0. |

**********  **********  **********  **********  **********

SUB-AREA RUNOFF COMPUTATION

RUNOFF TO LOWER DAM, 10 -YR FLOOD BASED ON SULLIVAN PRECIP, 10-MIN. INCR.

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|
| INFLOW | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |

HYDROGRAPH DATA

| IHYDG | IUHG | TAREA | SNAP | TRSDA | TRSPC | RATIO | ISNOW | ISAME | LOCAL |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 2 | .06 | 0.00 | .06 | 0.00 | 0.000 | 0 | 0 | 0 |

PRECIP DATA

| NP | STORM | DAJ | DAK |
|---|---|---|---|
| -144 | 0.00 | 0.00 | 0.00 |

LOSS DATA

| LROPT | STRKR | DLTKR | RTIOL | ERAIN | STRKS | RTIOK | STRTL | CNSTL | ALSMX | RTIMP |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | 1.00 | -1.00 | -100.00 | 0.00 | 0.00 |

CURVE NO = -100.00  WETNESS = -1.00  EFFECT CN = 100.00

UNIT HYDROGRAPH DATA

TC= 0.00  LAG= .10

RECESSION DATA

STRTQ= -.01  QRCSN= -.01  RTIOR= 1.00

TIME INCREMENT TOO LARGE--(NHQ IS GT LAG/2)

UNIT HYDROGRAPH 5 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .10 VOL= 1.00

154. 59. 14. 3. 1.

| 0 MO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | END-OF-PERIOD FLOW COMP Q | MO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | COMP Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.01 | .10 | 1 | .01 | .01 | 0.00 | 2. | 1.01 | 12.10 | 73 | .05 | .05 | -.00 | 166. |
| 1.01 | .20 | 2 | .01 | .01 | 0.00 | 2. | 1.01 | 12.20 | 74 | .05 | .05 | -.00 | 96. |
| 1.01 | .30 | 3 | .01 | .01 | 0.00 | 2. | 1.01 | 12.30 | 75 | .17 | .17 | .00 | 54. |
| 1.01 | .40 | 4 | .01 | .01 | 0.00 | 2. | 1.01 | 12.40 | 76 | .10 | .10 | .00 | 32. |
| 1.01 | .50 | 5 | .01 | .01 | 0.00 | 2. | 1.01 | 12.50 | 77 | .10 | .10 | .00 | 25. |
| 1.01 | 1.00 | 6 | .01 | .01 | 0.00 | 2. | 1.01 | 13.00 | 78 | .10 | .10 | .00 | 23. |
| 1.01 | 1.10 | 7 | .01 | .01 | .00 | 2. | 1.01 | 13.10 | 79 | .06 | .06 | .00 | 17. |
| 1.01 | 1.20 | 8 | .01 | .01 | -.00 | 2. | 1.01 | 13.20 | 80 | .06 | .06 | -.00 | 15. |
| 1.01 | 1.30 | 9 | .01 | .01 | -.00 | 2. | 1.01 | 13.30 | 81 | .06 | .06 | -.00 | 14. |
| 1.01 | 1.40 | 10 | .01 | .01 | -.00 | 2. | 1.01 | 13.40 | 82 | .03 | .03 | .00 | 9. |
| 1.01 | 1.50 | 11 | .01 | .01 | -.00 | 2. | 1.01 | 13.50 | 83 | .03 | .03 | -.00 | 7. |
| 1.01 | 2.00 | 12 | .01 | .01 | -.00 | 2. | 1.01 | 14.00 | 84 | .03 | .03 | -.00 | 7. |
| 1.01 | 2.10 | 13 | .01 | .01 | .00 | 2. | 1.01 | 14.10 | 85 | .03 | .03 | -.00 | 7. |
| 1.01 | 2.20 | 14 | .01 | .01 | .00 | 2. | 1.01 | 14.20 | 86 | .03 | .03 | -.00 | 7. |
| 1.01 | 2.30 | 15 | .01 | .01 | .00 | 2. | 1.01 | 14.30 | 87 | .03 | .03 | -.00 | 7. |
| 1.01 | 2.40 | 16 | .01 | .01 | .00 | 2. | 1.01 | 14.40 | 88 | .03 | .03 | -.00 | 7. |
| 1.01 | 2.50 | 17 | .01 | .01 | .00 | 2. | 1.01 | 14.50 | 89 | .03 | .03 | -.00 | 7. |
| 1.01 | 3.00 | 18 | .01 | .01 | .00 | 2. | 1.01 | 15.00 | 90 | .03 | .03 | -.00 | 7. |
| 1.01 | 3.10 | 19 | .01 | .01 | -.00 | 2. | 1.01 | 15.10 | 91 | .02 | .02 | -.00 | 5. |
| 1.01 | 3.20 | 20 | .01 | .01 | .00 | 2. | 1.01 | 15.20 | 92 | .02 | .02 | -.00 | 5. |
| 1.01 | 3.30 | 21 | .01 | .01 | -.00 | 2. | 1.01 | 15.30 | 93 | .02 | .02 | -.00 | 5. |
| 1.01 | 3.40 | 22 | .01 | .01 | .00 | 2. | 1.01 | 15.40 | 94 | .02 | .02 | -.00 | 5. |
| 1.01 | 3.50 | 23 | .01 | .01 | .00 | 2. | 1.01 | 15.50 | 95 | .02 | .02 | -.00 | 5. |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.01 | 4.10 | 25 | .01 | .01 | .00 | 2. | 1.01 | 16.10 | 97 | .02 | .02 | -.00 | 5. |
| 1.01 | 4.20 | 26 | .01 | .01 | .00 | 2. | 1.01 | 16.20 | 98 | .02 | .02 | .00 | 5. |
| 1.01 | 4.30 | 27 | .01 | .01 | -.00 | 2. | 1.01 | 16.30 | 99 | .02 | .02 | -.00 | 5. |
| 1.01 | 4.40 | 28 | .01 | .01 | .00 | 2. | 1.01 | 16.40 | 100 | .02 | .02 | -.00 | 5. |
| 1.01 | 4.50 | 29 | .01 | .01 | -.00 | 2. | 1.01 | 16.50 | 101 | .02 | .02 | -.00 | 5. |
| 1.01 | 5.00 | 30 | .01 | .01 | .00 | 2. | 1.01 | 17.00 | 102 | .02 | .02 | .00 | 5. |
| 1.01 | 5.10 | 31 | .01 | .01 | -.00 | 2. | 1.01 | 17.10 | 103 | .02 | .02 | -.00 | 5. |
| 1.01 | 5.20 | 32 | .01 | .01 | .00 | 2. | 1.01 | 17.20 | 104 | .02 | .02 | -.00 | 5. |
| 1.01 | 5.30 | 33 | .01 | .01 | .00 | 2. | 1.01 | 17.30 | 105 | .02 | .02 | -.00 | 5. |
| 1.01 | 5.40 | 34 | .01 | .01 | .00 | 2. | 1.01 | 17.40 | 106 | .02 | .02 | -.00 | 5. |
| 1.01 | 5.50 | 35 | .01 | .01 | .00 | 2. | 1.01 | 17.50 | 107 | .02 | .02 | .00 | 5. |
| 1.01 | 6.00 | 36 | .01 | .01 | .00 | 2. | 1.01 | 18.00 | 108 | .02 | .02 | -.00 | 5. |
| 1.01 | 6.10 | 37 | .02 | .02 | -.00 | 4. | 1.01 | 18.10 | 109 | .01 | .01 | .00 | 3. |
| 1.01 | 6.20 | 38 | .02 | .02 | .00 | 4. | 1.01 | 18.20 | 110 | .01 | .01 | .00 | 2. |
| 1.01 | 6.30 | 39 | .02 | .02 | -.00 | 5. | 1.01 | 18.30 | 111 | .01 | .01 | .00 | 2. |
| 1.01 | 6.40 | 40 | .02 | .02 | .00 | 5. | 1.01 | 18.40 | 112 | .01 | .01 | -.00 | 2. |
| 1.01 | 6.50 | 41 | .02 | .02 | .00 | 5. | 1.01 | 18.50 | 113 | .01 | .01 | .00 | 2. |
| 1.01 | 7.00 | 42 | .02 | .02 | .00 | 5. | 1.01 | 19.00 | 114 | .01 | .01 | .00 | 2. |
| 1.01 | 7.10 | 43 | .02 | .02 | -.00 | 5. | 1.01 | 19.10 | 115 | .01 | .01 | .00 | 2. |
| 1.01 | 7.20 | 44 | .02 | .02 | .00 | 5. | 1.01 | 19.20 | 116 | .01 | .01 | .00 | 2. |
| 1.01 | 7.30 | 45 | .02 | .02 | -.00 | 5. | 1.01 | 19.30 | 117 | .01 | .01 | .00 | 2. |
| 1.01 | 7.40 | 46 | .02 | .02 | .00 | 5. | 1.01 | 19.40 | 118 | .01 | .01 | .00 | 2. |
| 1.01 | 7.50 | 47 | .02 | .02 | .00 | 5. | 1.01 | 19.50 | 119 | .01 | .01 | .00 | 2. |
| 1.01 | 8.00 | 48 | .02 | .02 | .00 | 5. | 1.01 | 20.00 | 120 | .01 | .01 | .00 | 2. |
| 1.01 | 8.10 | 49 | .02 | .02 | .00 | 5. | 1.01 | 20.10 | 121 | .01 | .01 | .00 | 2. |
| 1.01 | 8.20 | 50 | .02 | .02 | .00 | 5. | 1.01 | 20.20 | 122 | .01 | .01 | -.00 | 2. |
| 1.01 | 8.30 | 51 | .02 | .02 | .00 | 5. | 1.01 | 20.30 | 123 | .01 | .01 | .00 | 2. |
| 1.01 | 8.40 | 52 | .02 | .02 | .00 | 5. | 1.01 | 20.40 | 124 | .01 | .01 | -.00 | 2. |
| 1.01 | 8.50 | 53 | .02 | .02 | .00 | 5. | 1.01 | 20.50 | 125 | .01 | .01 | .00 | 2. |
| 1.01 | 9.00 | 54 | .02 | .02 | .00 | 5. | 1.01 | 21.00 | 126 | .01 | .01 | .00 | 2. |
| 1.01 | 9.10 | 55 | .03 | .03 | .00 | 6. | 1.01 | 21.10 | 127 | .01 | .01 | .00 | 2. |
| 1.01 | 9.20 | 56 | .03 | .03 | -.00 | 7. | 1.01 | 21.20 | 128 | .01 | .01 | .00 | 2. |
| 1.01 | 9.30 | 57 | .03 | .03 | .00 | 7. | 1.01 | 21.30 | 129 | .01 | .01 | .00 | 2. |
| 1.01 | 9.40 | 58 | .03 | .03 | -.00 | 7. | 1.01 | 21.40 | 130 | .01 | .01 | .00 | 2. |
| 1.01 | 9.50 | 59 | .03 | .03 | -.00 | 7. | 1.01 | 21.50 | 131 | .01 | .01 | .00 | 2. |
| 1.01 | 10.00 | 60 | .03 | .03 | -.00 | 7. | 1.01 | 22.00 | 132 | .01 | .01 | .00 | 2. |
| 1.01 | 10.10 | 61 | .03 | .03 | .00 | 7. | 1.01 | 22.10 | 133 | .01 | .01 | -.00 | 2. |
| 1.01 | 10.20 | 62 | .03 | .03 | -.00 | 7. | 1.01 | 22.20 | 134 | .01 | .01 | .00 | 2. |
| 1.01 | 10.30 | 63 | .03 | .03 | -.00 | 7. | 1.01 | 22.30 | 135 | .01 | .01 | .00 | 2. |
| 1.01 | 10.40 | 64 | .06 | .06 | .00 | 12. | 1.01 | 22.40 | 136 | .01 | .01 | .00 | 2. |
| 1.01 | 10.50 | 65 | .06 | .06 | .00 | 14. | 1.01 | 22.50 | 137 | .01 | .01 | .00 | 2. |
| 1.01 | 11.00 | 66 | .06 | .06 | .00 | 14. | 1.01 | 23.00 | 138 | .01 | .01 | .00 | 2. |
| 1.01 | 11.10 | 67 | .10 | .10 | -.00 | 20. | 1.01 | 23.10 | 139 | .01 | .01 | .00 | 2. |
| 1.01 | 11.20 | 68 | .10 | .10 | .00 | 22. | 1.01 | 23.20 | 140 | .01 | .01 | .00 | 2. |
| 1.01 | 11.30 | 69 | .10 | .10 | .00 | 22. | 1.01 | 23.30 | 141 | .01 | .01 | .00 | 2. |
| 1.01 | 11.40 | 70 | .17 | .17 | .00 | 34. | 1.01 | 23.40 | 142 | .01 | .01 | .00 | 2. |
| 1.01 | 11.50 | 71 | .25 | .25 | -.00 | 50. | 1.01 | 23.50 | 143 | .01 | .01 | .00 | 2. |
| 1.01 | 12.00 | 72 | .54 | .54 | .00 | 100. | 1.02 | 0.00 | 144 | .01 | .01 | .00 | 2. |
| | | | | | | | | | SUM | 5.17 | 5.17 | .00 | 1180. |
| | | | | | | | | | | ( 131.)( | 131.)( | 0.)( | 33.41) |

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 166. | 24. | 8. | 8. | 1185. |
| CMS | 5. | 1. | 0. | 0. | 34. |
| INCHES | | 3.72 | 5.15 | 5.15 | 5.15 |
| MM | | 94.49 | 130.91 | 130.91 | 130.91 |
| AC-FT | | 12. | 16. | 16. | 16. |
| THOUS CU M | | 15. | 20. | 20. | 20. |

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COMBINE HYDROGRAPHS

COMBINATION OF OUTFLOW FROM UPPER DIKE AND RUNOFF FROM LOWER WATERSHED

| | ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|---|
| | UP+LOW | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

SUM OF 2 HYDROGRAPHS ATUP+LOW

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2. | 2. | 3. | 3. | 3. | 3. | 3. | 3. | 3. | 3. |
| 3. | 3. | 3. | 3. | 3. | 3. | 3. | 3. | 3. | 3. |
| 3. | 3. | 3. | 3. | 3. | 3. | 3. | 3. | 3. | 3. |
| 3. | 3. | 3. | 3. | 3. | 3. | 5. | 5. | 6. | 6. |
| 6. | 6. | 6. | 6. | 6. | 6. | 6. | 6. | 6. | 6. |
| 6. | 6. | 6. | 6. | 7. | 8. | 8. | 8. | 8. | 8. |
| 8. | 8. | 8. | 13. | 15. | 16. | 21. | 23. | 24. | 35. |
| 52. | 102. | 168. | 98. | 57. | 35. | 29. | 29. | 24. | 24. |
| 24. | 21. | 20. | 20. | 21. | 21. | 22. | 23. | 23. | 24. |
| 23. | 22. | 22. | 22. | 22. | 22. | 22. | 21. | 21. | 21. |
| 21. | 20. | 20. | 20. | 20. | 19. | 19. | 19. | 18. | 17. |
| 17. | 16. | 16. | 16. | 16. | 16. | 16. | 16. | 15. | 15. |
| 15. | 15. | 15. | 15. | 14. | 14. | 14. | 14. | 14. | 14. |
| 13. | 13. | 13. | 13. | 13. | 13. | 13. | 13. | 12. | 12. |
| 12. | 12. | 12. | 12. | | | | | | |

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 168. | 33. | 15. | 15. | 2147. |
| CMS | 5. | 1. | 0. | 0. | 61. |
| INCHES | | .76 | 1.37 | 1.37 | 1.37 |
| MM | | 19.35 | 34.68 | 34.68 | 34.68 |
| AC-FT | | 16. | 30. | 30. | 30. |
| THOUS CU M | | 20. | 36. | 36. | 36. |

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HYDROGRAPH ROUTING

ROUTING THROUGH LAKE, CLOSED SYSTEM

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|
| POND 2 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |

ROUTING DATA

| QLOSS | CLOSS | AVG | IRES | ISAME | IOPT | IPMP | | LSTR |
|---|---|---|---|---|---|---|---|---|
| 0.0 | 0.000 | 0.00 | 1 | 0 | 0 | 0 | | 0 |

| NSTPS | NSTDL | LAG | AMSKK | X | TSK | STORA | ISPPAT |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0.000 | 0.000 | 0.000 | -897. | -1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| STAGE | 897.70 | 898.00 | 898.50 | 899.00 | 899.50 | 900.00 |
| FLOW | 0.00 | 25.00 | 165.00 | 425.00 | 825.00 | 1350.00 |
| SURFACE AREA= | 0. | 3. | 10. | 14. | 18. | 22. |
| CAPACITY= | 0. | 2. | 14. | 26. | 42. | 62. |
| ELEVATION= | 893. | 895. | 897. | 898. | 899. | 900. |

| CREL | SPWID | COQW | EXPW | FLEVI | COQL | CAREA | EXPL |
|---|---|---|---|---|---|---|---|
| 897.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

DAM DATA

| TOPEL | COQD | EXPD | DAMWID |
|---|---|---|---|
| 897.7 | 0.0 | 0.0 | 0. |

RUNOFF SUMMARY, AVERAGE FLOW IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES(SQUARE KILOMETERS)

| | | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | AREA |
|---|---|---|---|---|---|---|
| HYDROGRAPH AT | INFLOW | 59. | 26. | 9. | 9. | .35 |
| | | ( 1.66)( | .73)( | .25)( | .25)( | .90) |
| ROUTED TO | POND 1 | 17. | 15. | 7. | 7. | .35 |
| | | ( .49)( | .43)( | .19)( | .19)( | .90) |
| HYDROGRAPH AT | INFLOW | 166. | 24. | 8. | 8. | .06 |
| | | ( 4.69)( | .67)( | .23)( | .23)( | .15) |
| 2-COMBINED | UP+LOW | 168. | 33. | 15. | 15. | .41 |
| | | ( 4.75)( | .94)( | .42)( | .42)( | 1.05) |
| ROUTED TO | POND 2 | 22. | 21. | 9. | 9. | .41 |
| | | ( .62)( | .61)( | .26)( | .26)( | 1.05) |

PLAN 1 .....

| | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 900.00 | 900.00 | 904.50 |
| STORAGE | 18. | 18. | 59. |
| OUTFLOW | 0. | 0. | 270. |

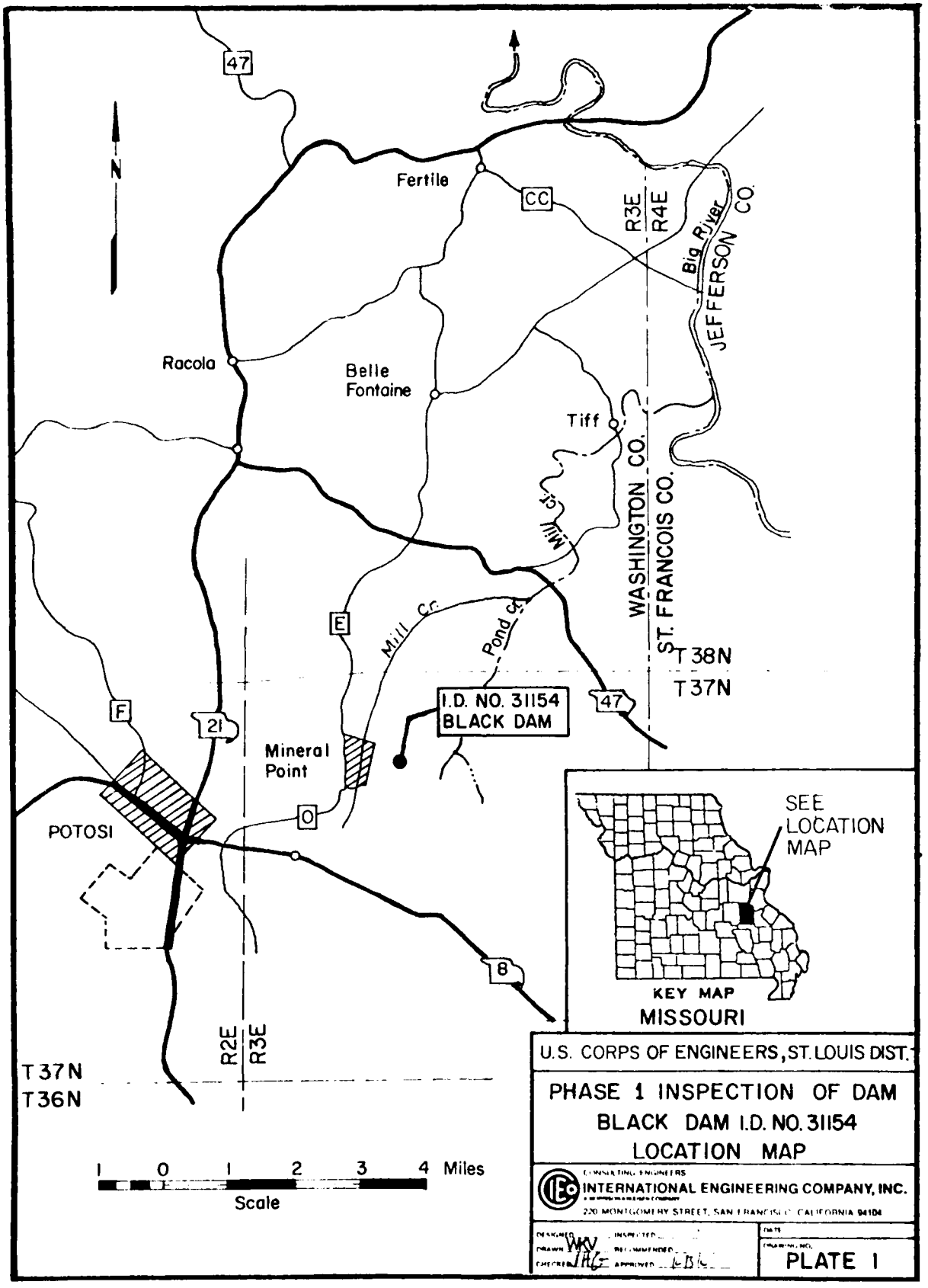
| MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|
| 901.06 | 0.00 | 26. | 17. | 0.00 | 15.50 | 0.00 |

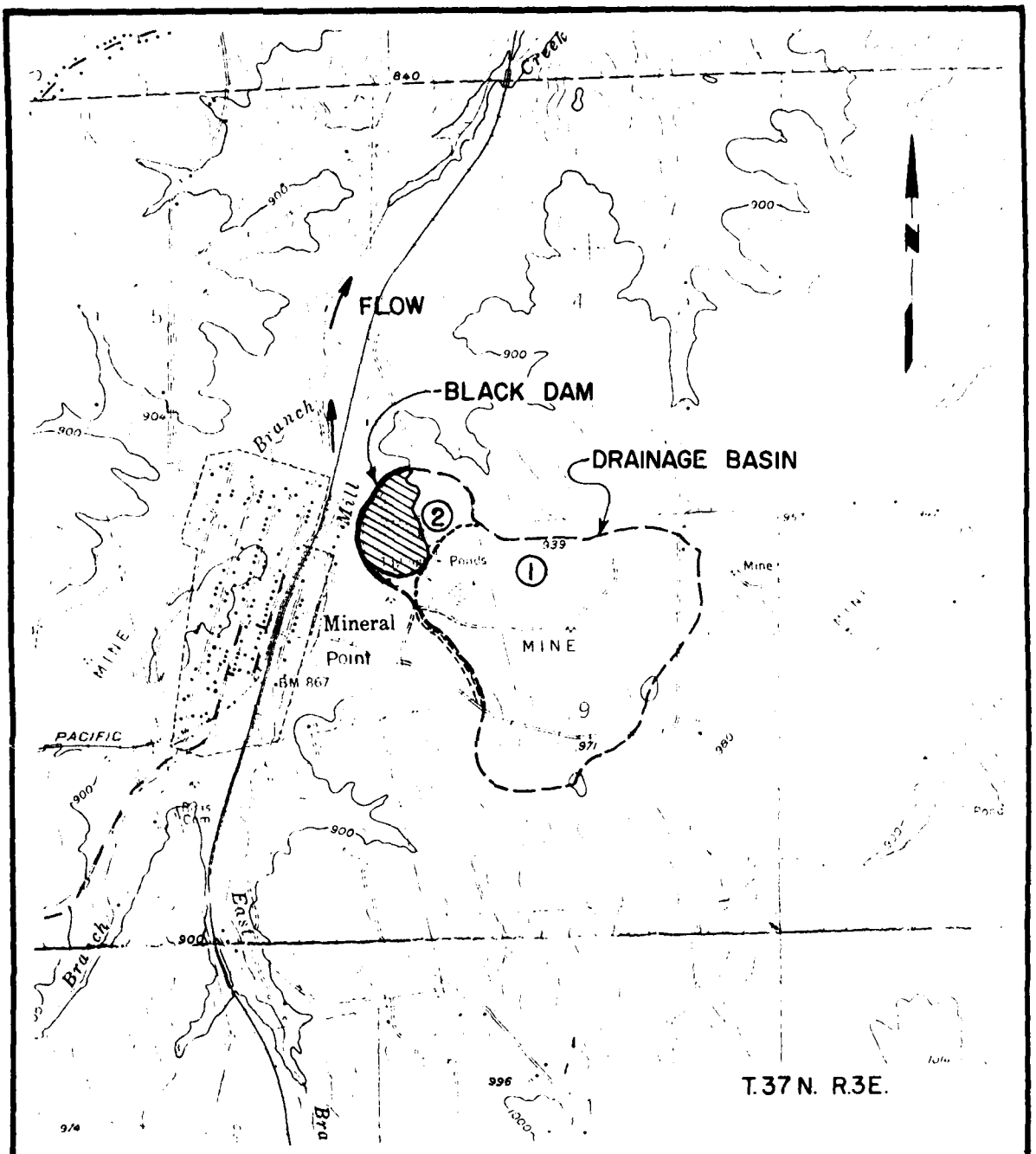
SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ...10-yr.....

| | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 896.90 | 897.70 | 897.70 |
| STORAGE | 13. | 22. | 22. |
| OUTFLOW | 0. | 0. | 0. |

| MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|
| 897.36 | .26 | 26. | 22. | 12.00 | 15.83 | 0.00 |


47
N
Fertile
CC
R3E
R4E
Big River
JEFFERSON CO.
Racola
Belle
Fontaine
Tiff
WASHINGTON CO.
ST. FRANCOIS CO.
Mill Cr.
Pond Cr.
E
T 38N
T 37N
I.D. NO. 31154
BLACK DAM
47
F
21
Mineral
Point
O
POTOSI
8
SEE
LOCATION
MAP
KEY MAP
MISSOURI
R2E
R3E
T37N
T36N
1 0 1 2 3 4 Miles
Scale
U.S. CORPS OF ENGINEERS, ST. LOUIS DIST.
PHASE 1 INSPECTION OF DAM
BLACK DAM I.D. NO. 31154
LOCATION MAP
CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING COMPANY, INC.
220 MONTGOMERY STREET, SAN FRANCISCO, CALIFORNIA 94104
DESIGNED
DRAWN WKV
CHECKED JAG
INSPECTED
RECOMMENDED
APPROVED
DATE
DRAWING NO.
PLATE 1




① Drainage Sub-Area 1
② Drainage Sub-Area 2

Scale 1000 0 1000 2000 3000 4000 Feet

U.S. CORPS OF ENGINEERS, ST. LOUIS DIST.

PHASE I INSPECTION OF DAMS
BLACK DAM I.D. NO. 31154
VICINITY TOPOGRAPHY

CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING COMPANY, INC.
220 MONTGOMERY STREET, SAN FRANCISCO, CALIFORNIA 94104

DESIGNED ____ INSPECTED ____ DATE
DRAWN DD RECOMMENDED ____ DRAWING NO.
CHECKED ____ APPROVED ____ PLATE 2

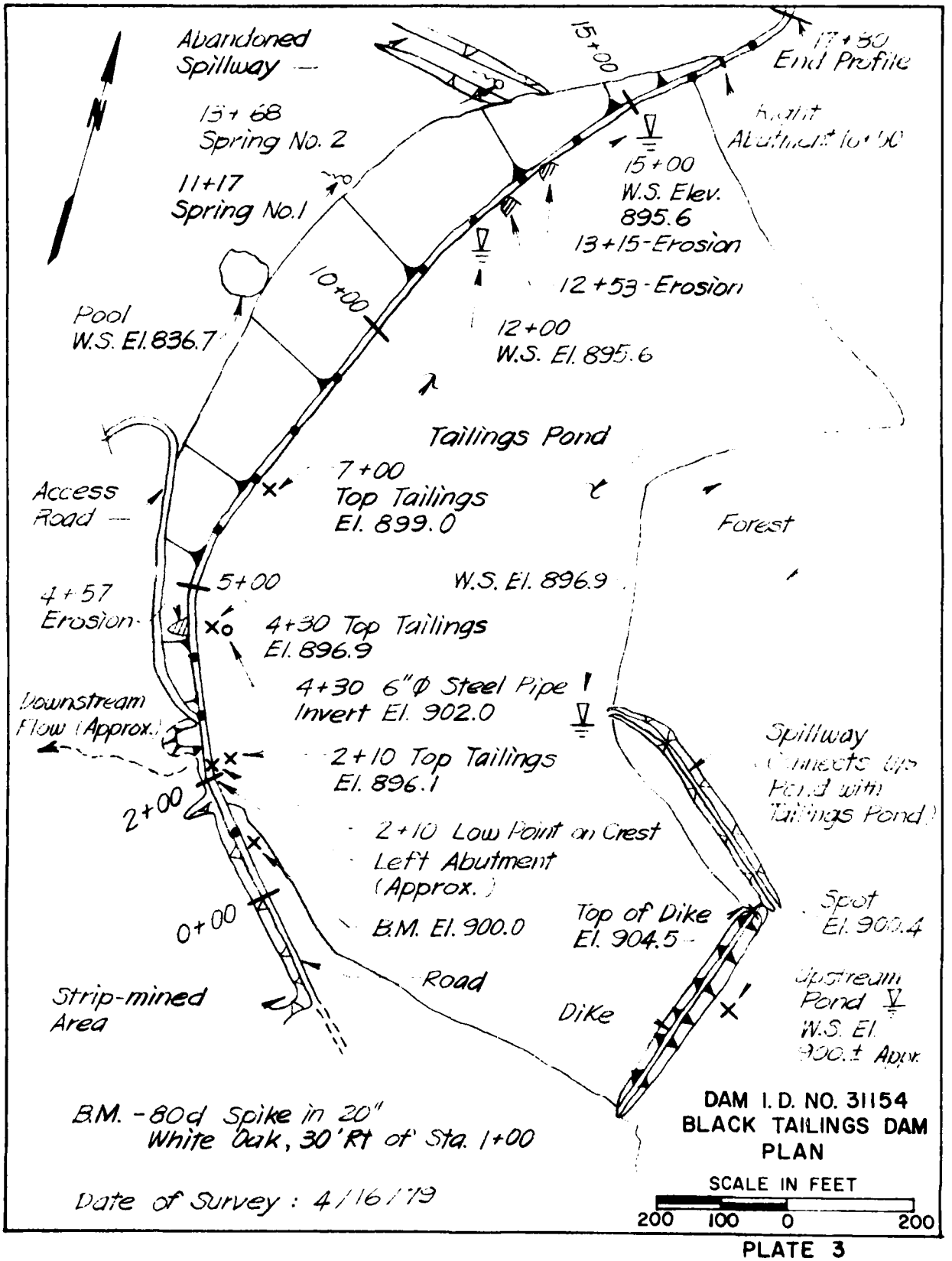
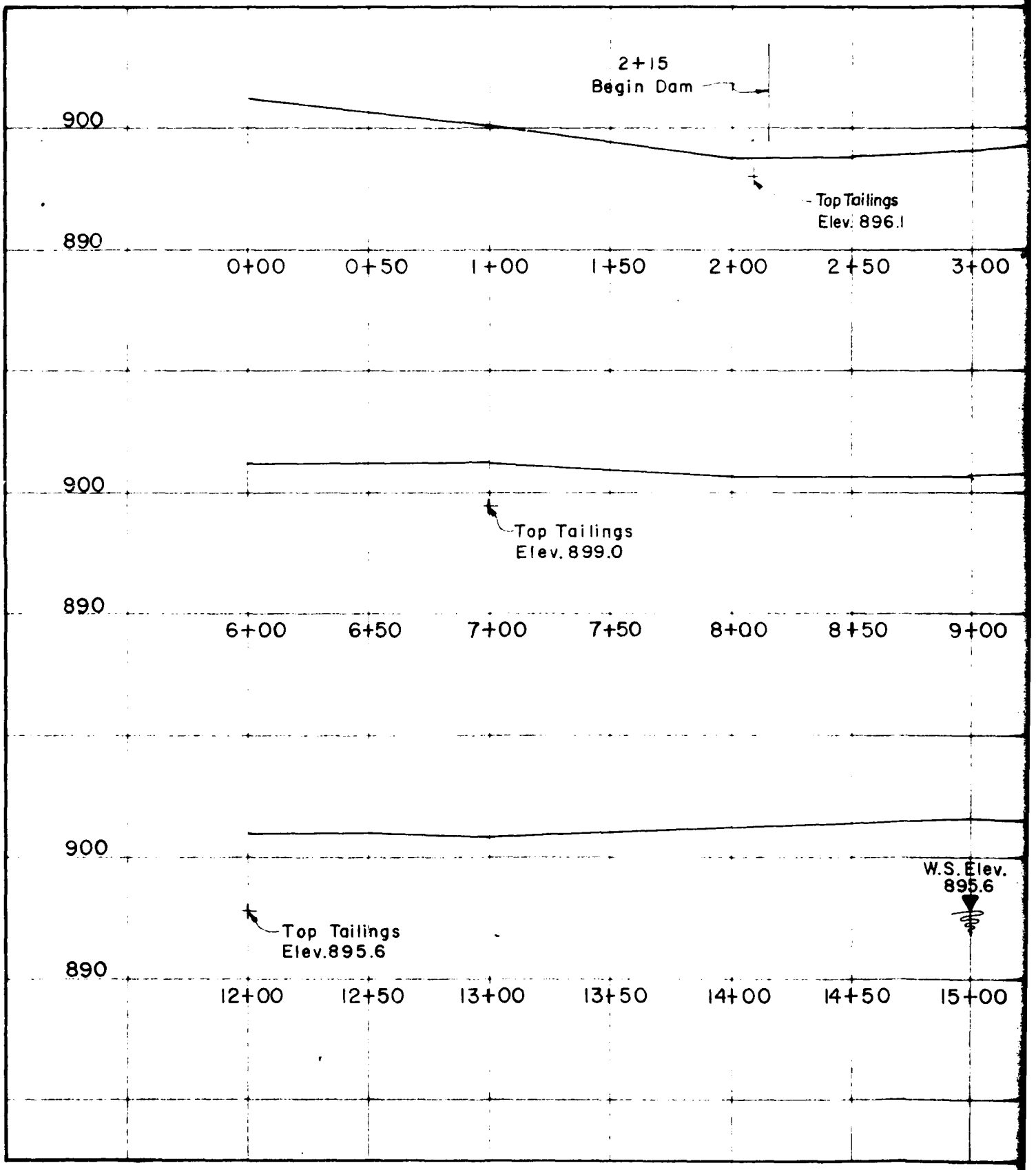
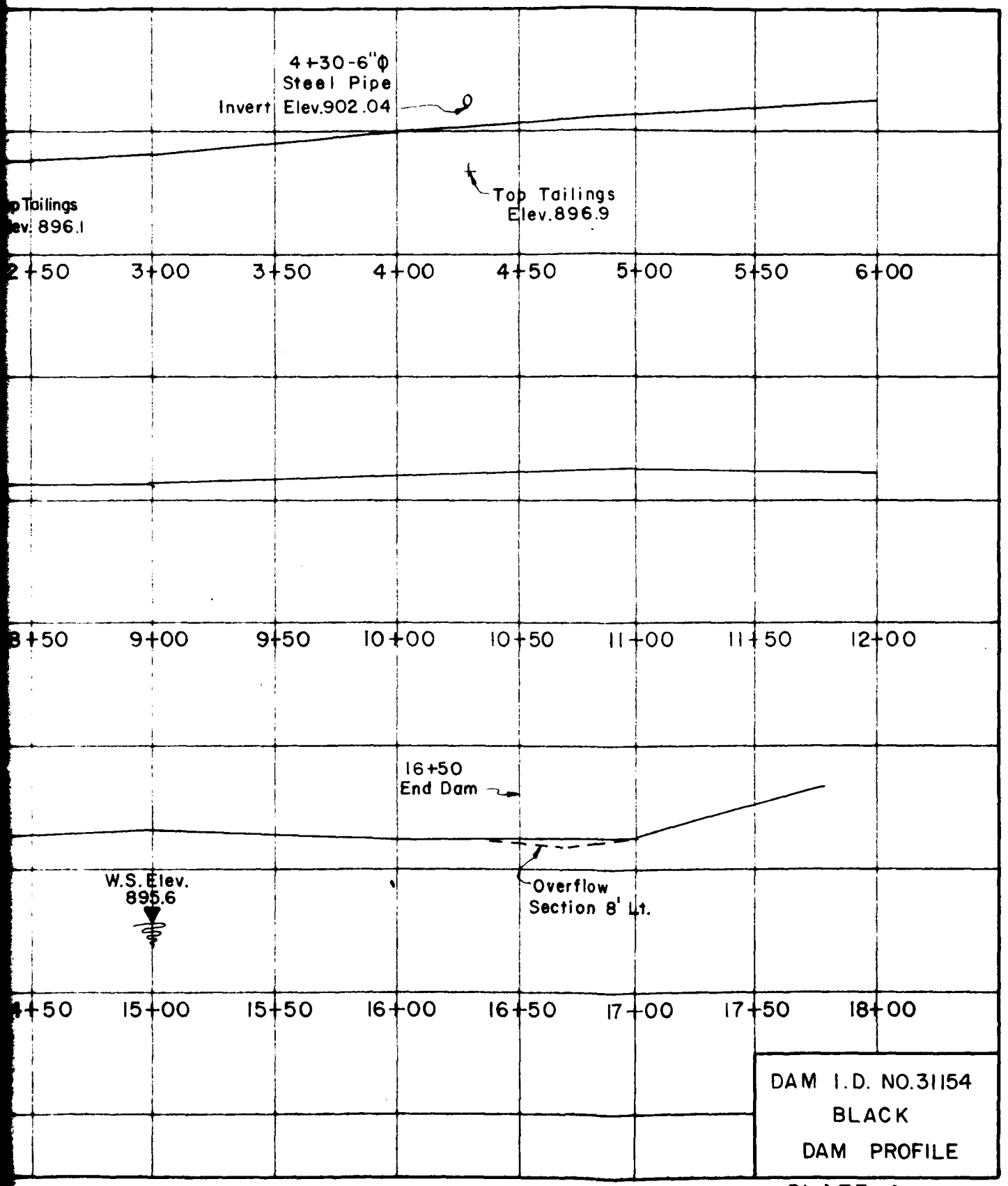

Abandoned Spillway
15+68 Spring No. 2
11+17 Spring No. 1
Pool W.S. El. 836.7
10+00
15+00
17+50 End Profile
Right Abutment 10' DC
15+00 W.S. Elev. 895.6
13+15-Erosion
12+53-Erosion
12+00 W.S. El. 895.6
Tailings Pond
7+00 Top Tailings El. 899.0
Access Road
Forest
4+57 Erosion
5+00
W.S. El. 896.9
4+30 Top Tailings El. 896.9
4+30 6"Ø Steel Pipe Invert El. 902.0
Downstream Flow (Approx.)
2+10 Top Tailings El. 896.1
Spillway (Connects Upper Pond with Tailings Pond)
2+00
2+10 Low Point on Crest Left Abutment (Approx.)
0+00
B.M. El. 900.0
Top of Dike El. 904.5
Spot El. 900.4
Road
Strip-mined Area
Dike
Upstream Pond W.S. El. 900.± Appx.
B.M. -80d Spike in 20" White Oak, 30' Rt of Sta. 1+00
Date of Survey: 4/16/79
DAM I. D. NO. 31154
BLACK TAILINGS DAM
PLAN
SCALE IN FEET
200 100 0 200

PLATE 3


2+15
Begin Dam
900
890
Top Tailings
Elev. 896.1
0+00
0+50
1+00
1+50
2+00
2+50
3+00
900
890
Top Tailings
Elev. 899.0
6+00
6+50
7+00
7+50
8+00
8+50
9+00
900
890
W.S. Elev.
895.6
Top Tailings
Elev. 895.6
12+00
12+50
13+00
13+50
14+00
14+50
15+00




DAM I.D. NO.31154
BLACK
DAM PROFILE

PLATE 4

2

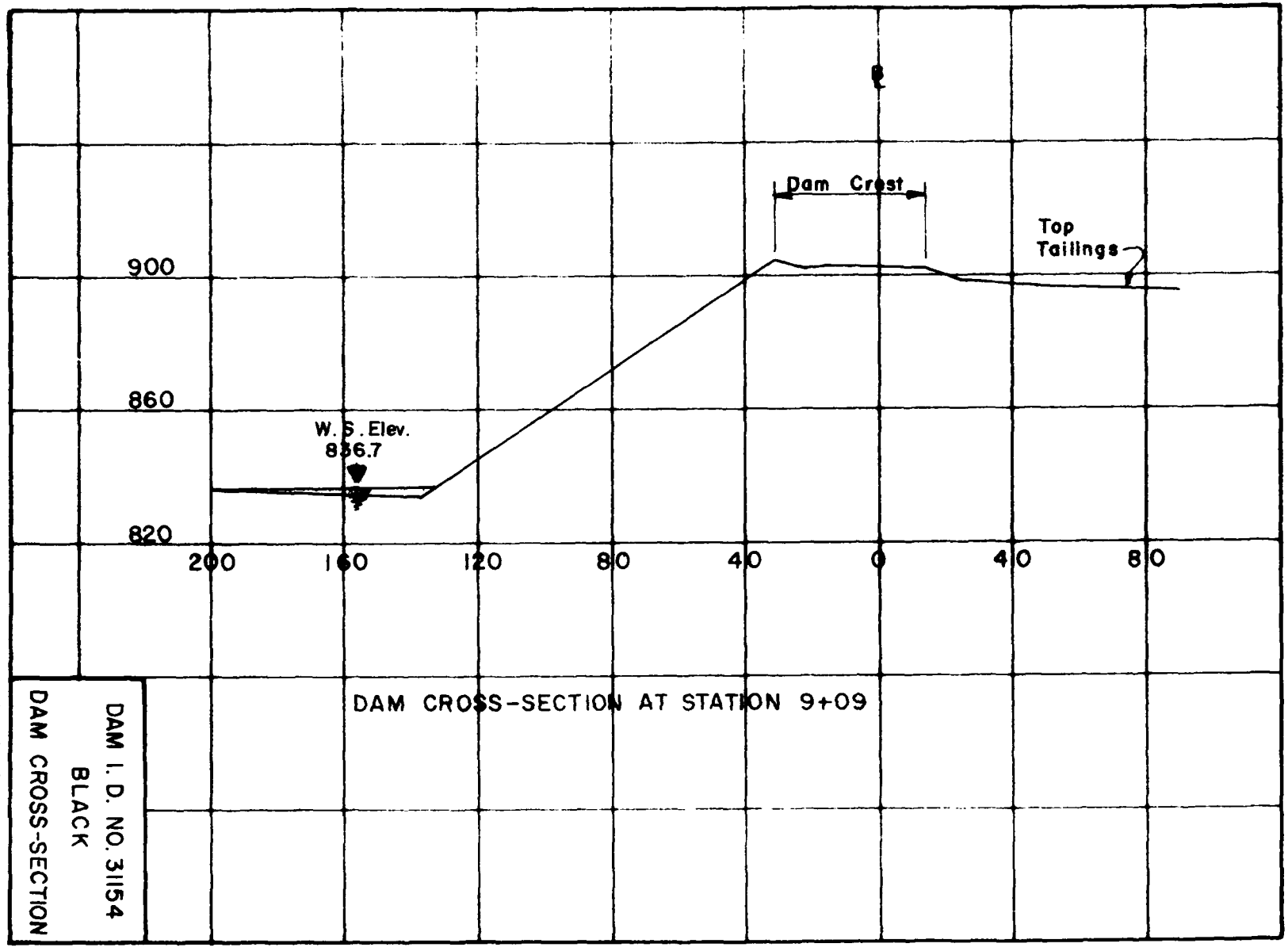
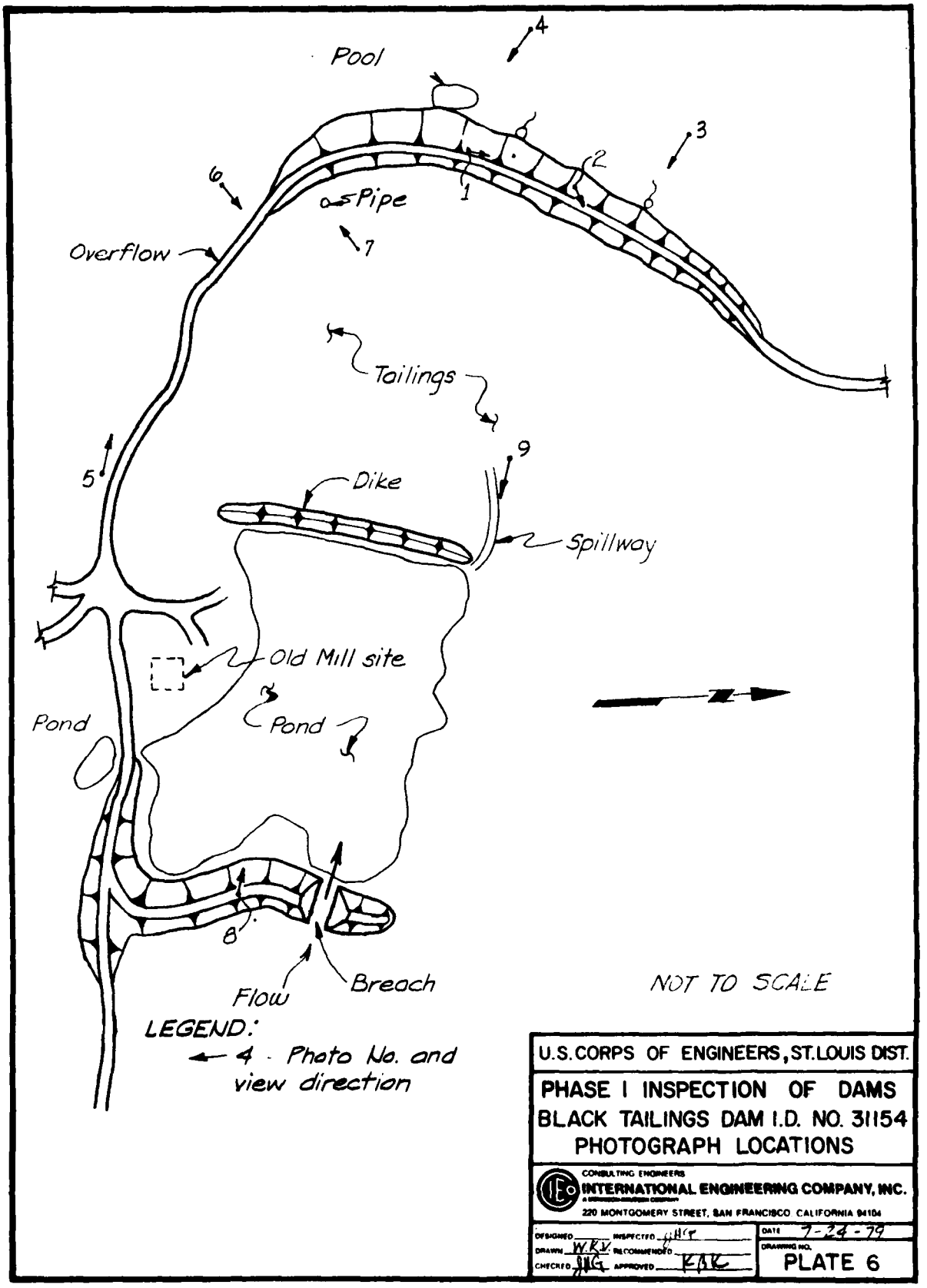



PLATE 5

DAM I. D. NO. 31154
BLACK
DAM CROSS-SECTION




U.S. CORPS OF ENGINEERS, ST. LOUIS DIST.

PHASE I INSPECTION OF DAMS
BLACK TAILINGS DAM I.D. NO. 31154
PHOTOGRAPH LOCATIONS

CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING COMPANY, INC.
220 MONTGOMERY STREET, SAN FRANCISCO CALIFORNIA 94104

| | | | |
|---|---|---|---|
| DESIGNED | INSPECTED HCT | DATE | 9-24-79 |
| DRAWN WKV | RECOMMENDED | DRAWING NO. | PLATE 6 |
| CHECKED JJG | APPROVED KBK | | |

PHOTOGRAPH RECORD

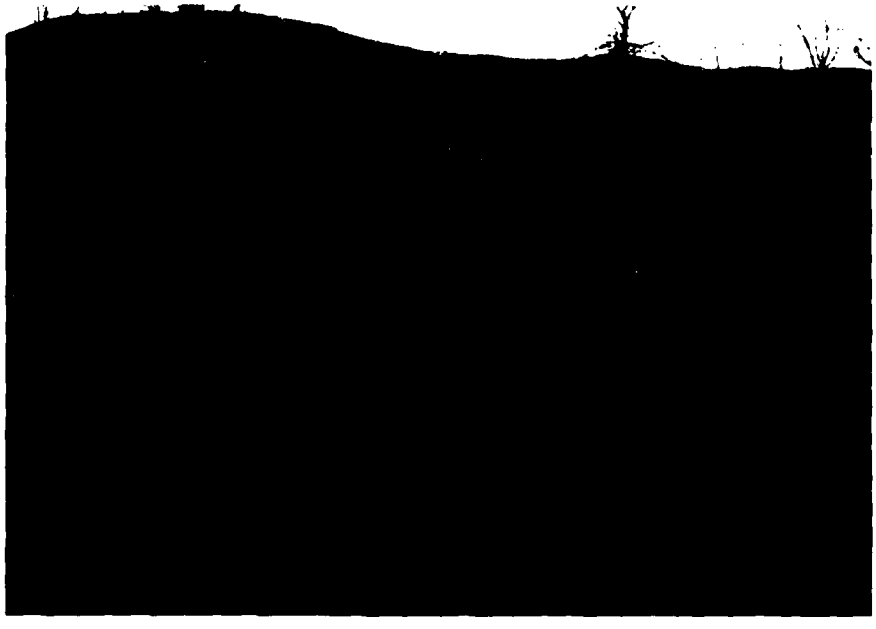
Black Tailings Dam I.D. No. 31154

| Photograph No. | Description |
|---|---|
| 1. | View towards north of embankment and crest. |
| 2. | Erosion on dam crest near Station 13+15 |
| 3. | Spring #2 flowing clear at 20 gpm at Station 13+68 |
| 4. | View upstream of pool at dam toe. |
| 5. | View west of dam and low spot on crest from left abutment area. |
| 6. | View upstream of low spot on crest of Station 2+10 |
| 7. | 6-inch pipe at Station 4+30. |
| 8. | View west of upstream pond. |
| 9. | View upstream of spillway connecting upstream pond with tailings impoundment. |

11

2

3



4

5

6

7

8